QUARTERLY REPORT NO. 7
(MARCH 1,1976 TO MAY 31,1976)

ENVIRONMENTAL BASELINE DATA COLLECTION

AND

MONITORING PROGRAM

FEDERAL PROTOTYPE OIL SHALE

LEASING PROGRAM

TRACTS U-a and U-b

UTAH

WHITE RIVER SHALE PROJECT

vtn

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VTN Colorado, Inc.
Denver, Colorado
July, 1976

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I. INTRODUCTION

This document is a summary of work conducted from March 1, 1976, to May 31, 1976, as part of the environmental baseline monitoring program for Tracts U-a and U-b. The baseline program is being conducted in accordance with the Partial Exploration Plan, Environmental Baseline Data Collection and Monitoring Element, submitted July 1, 1974, and the Conditions of Approval developed by the Area Oil Shale Supervisor (AOSS) for various sub-elements of the program. As requested by the AOSS, the field data collected for this quarter have also been submitted and are on file in the AOSS office in Grand Junction, Colorado.

This report includes the second-year monitoring programs for water, air, and biology. The soils and geology and historic and scientific resources programs are complete and are not reported. Special studies dealing with these completed programs will be reported as they occur.

II. WATER RESOURCES

A. WORK COMPLETED

1. SURFACE WATER

The surface water monitoring program continued, in compliance with the revised Conditions of Approval (January 26, 1976). Although the streamflow data for the quarter has been collected, it has not yet been analyzed by the subcontractor (USGS) and is therefore unavailable.

2. SURFACE WATER QUALITY

Water quality samples and precipitation and evaporation records have been collected and analyzed in accordance with the revised Conditions of Approval. Gaps in the data reported here do not indicate that data were not collected, but rather that it is either being reviewed for accuracy or has not yet been released by the laboratory.

3. GROUND WATER LEVEL MONITORING

Static water level measurements were taken in all monitoring wells during March, April, and May. Continuous water level monitoring was conducted at the P-1, P-2 upper, and P-2 lower sites. Equipment malfunction at the P-3 site caused an interruption in the record throughout most of May.

4. GROUND WATER QUALITY

As outlined in the January 26, 1976, Conditions of Approval, samples were collected from the alluvial wells in March, April, and May. Quarterly pumped samples were collected from the bedrock aquifer wells in March. All samples were submitted for analysis.

B. DATA SUMMARY

1. SURFACE WATER

a. Streamflow

White River, Evacuation Creek, and the Washes

Since the records have not yet been processed by the USGS, no data can be reported.

b. Precipitation and Evaporation

The precipitation records for the quarter are summarized in Table II-1.

2. SURFACE WATER QUALITY

a. White River

Figures II-1 through II-6 summarize the water quality results now available for this water year. Generally, the quality is similar to that of last year, but detailed analysis cannot take place without the streamflow records.

b. Evacuation Creek

Figures II-7 through II-12 summarize the water quality results available for Evacuation Creek. As with the White River it would be premature to draw conclusions without the streamflow data.

c. Hells Hole Canyon, Southam Canyon, and Asphalt Wash

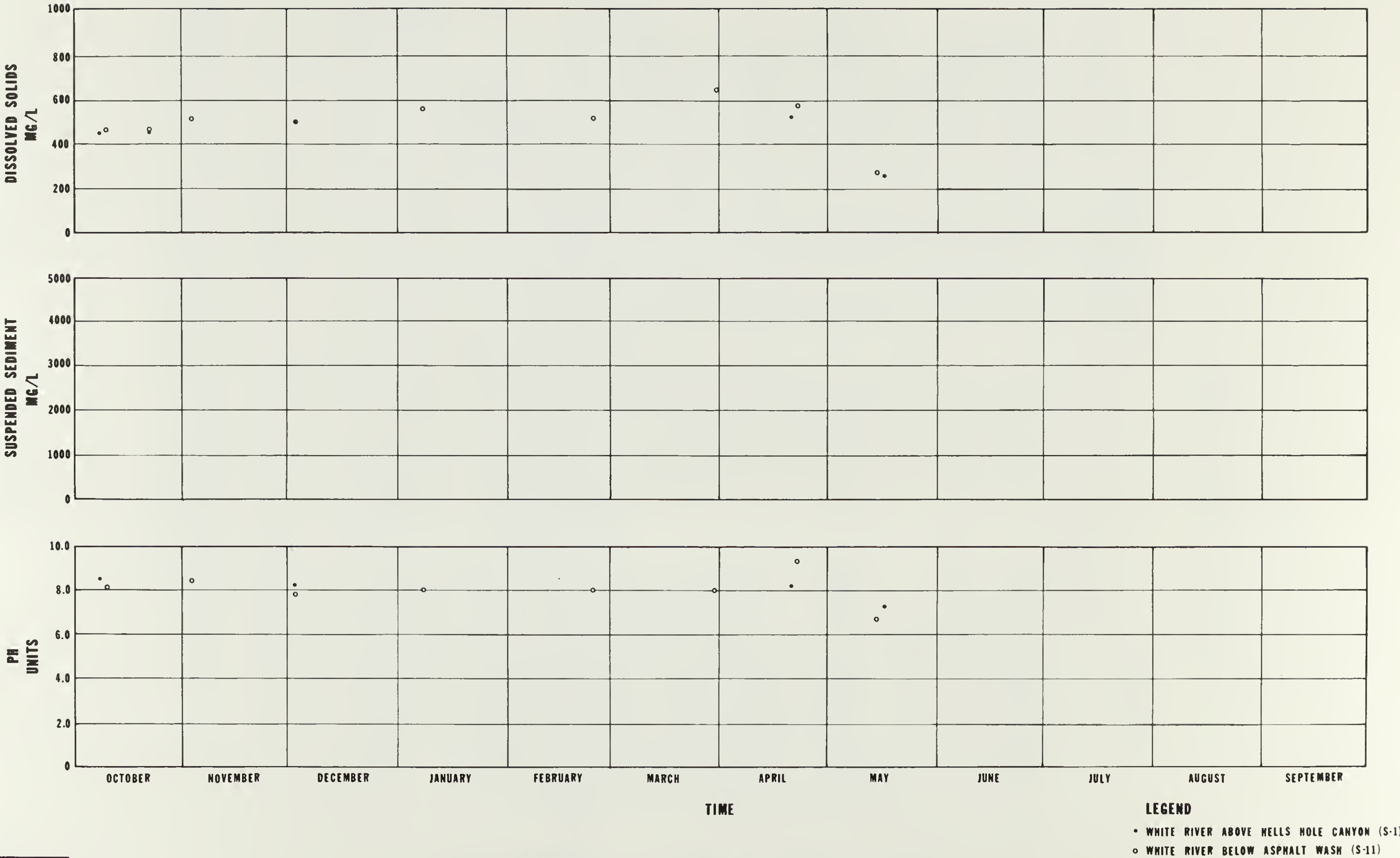
Although samples have been collected in the washes, the limited data available at this time and lack of streamflow information make data presentation premature.

TABLE II-1

PRECIPITATION SUMMARY
MARCH 1976 THROUGH MAY 1976

Station	Precipitation cm (in) March	April	May
Upper Evacuation Cr. RS-6	3.0 (1.2)	3.0 (1.3)	3.0 (1.2)
Lower Asphalt Wash RS-12	3.3 (1.3)	1.8 (0.7)	3.0 (1.2)
Lower White River RS-11	3.3 (1.3)	1.5 (0.6)	3.0 (1.2)
West Southam Canyon RS-2	2.8 (1.1)	1.8 (0.7)	3.0 (1.2)
Lower Southam Canyon RS-13	3.0 (1.2)	1.8 (0.7)	3.6 (1.4)
Upper Southam Canyon RS-9	3.3 (1.3)	2.5 (1.0)	3.3 (1.3)
Proposed Plant Site RS-RETORT	3.3 (1.3)	2.3 (0.9)	4.1 (1.6)
Intermediate White R. RS-4	3.3 (1.3)	2.0 (0.8)	4.3 (1.7)
West Evacuation Cr. RS-P1	2.3 (0.9)	2.3 (0.9)	2.5 (1.0)
East Evacuation Cr. RS-8	2.8 (1.1)	2.5 (1.0)	3.0 (1.2)
Upper White R. RS-1	1.0 (0.4)	2.8 (1.1)	3.0 (1.2)
West Evacuation Cr. AR-1	2.5 (1.0)	2.3 (0.9)	3.3 (1.3)
Intermediate White R. AR-4	2.3 (0.9)	1.8 (0.7)	4.6 (1.8)
Upper Southam Canyon AR-9	3.0 (1.2)	2.8 (1.1)	3.3 (1.3)
Lower Asphalt Wash AR-12	3.3 (1.3)	1.8 (0.7)	3.3 (1.3)
East Evacuation Cr. AR-8	2.0 (0.8)	2.3 (0.9)	3.0 (1.2)
West Southam Canyon AR-2	3.0 (1.2)	1.8 (0.7)	3.6 (1.4)

The highest rainfall intensity noted during this period was 1.0 cm (0.4 in.) of rain in 30 minutes at Station AR-4 on May 7. This was not an unusual occurrence, since the two-year event at Grand Junction is 1.8 cm (0.7 in.) in 30 minutes. Evaporation pan measurements showed 8.59 cm (3.38 in.) lost at EVAP-1 and 8.05 cm (3.17 in.) lost at EVAP-2 during May.

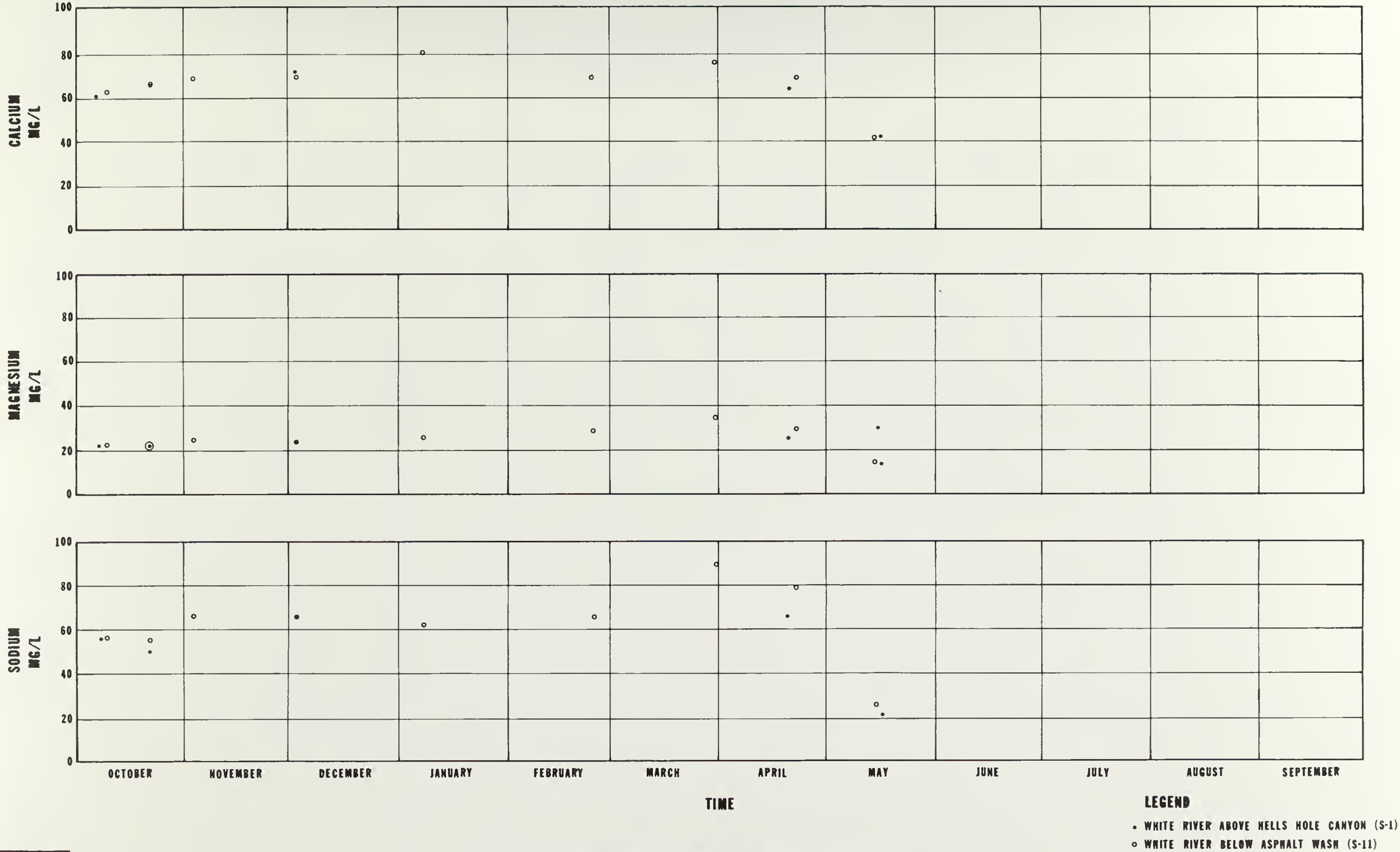


VARIATION OF GENERAL CHARACTERISTICS

WHITE RIVER ABOVE HELLS HOLE CANYON (S-1) AND WHITE RIVER BELOW ASPHALT WASH (S-11)

OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-1

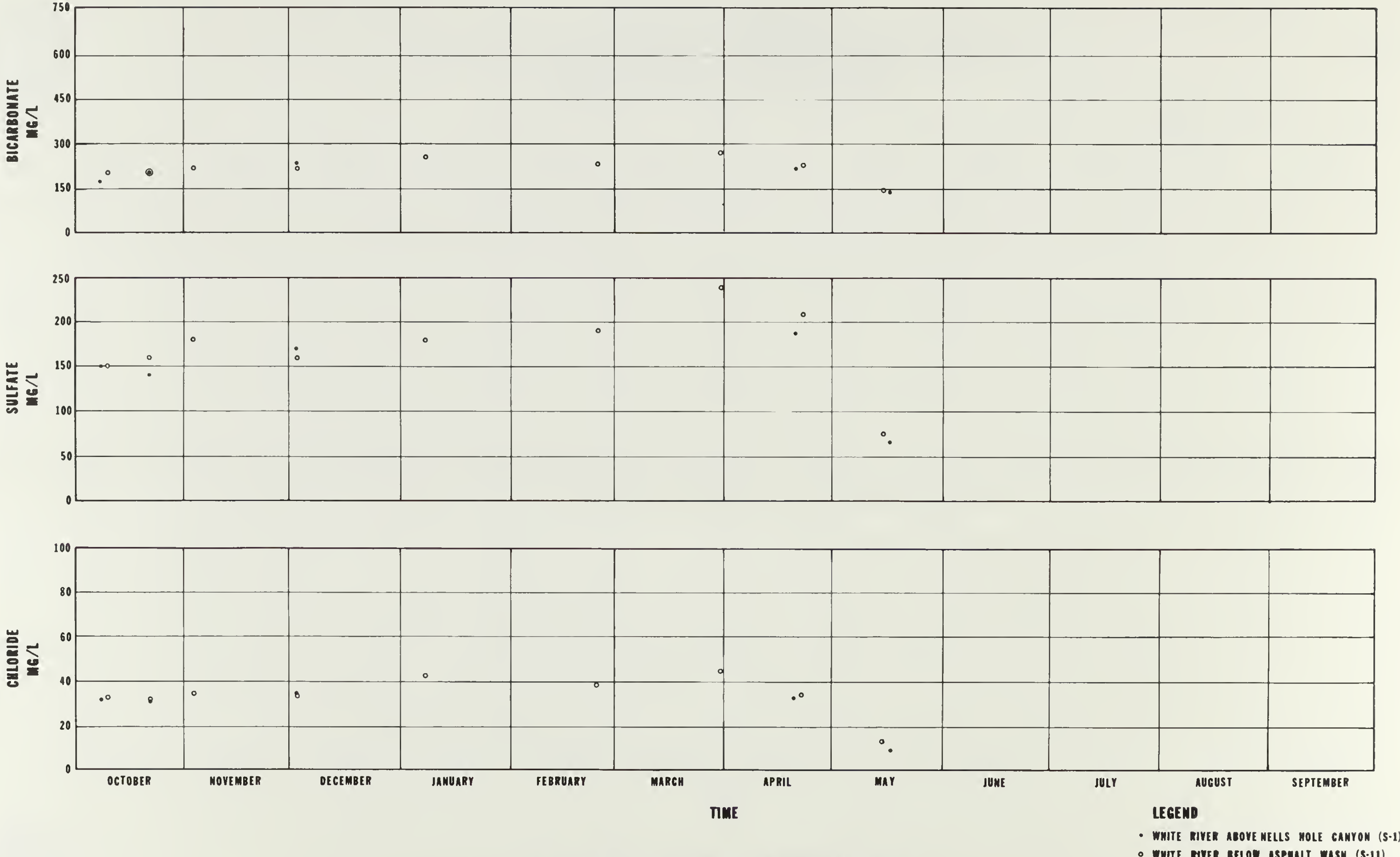


VARIATION IN TIME OF MAJOR CATIONS

WHITE RIVER ABOVE HELLS HOLE CANYON (S-1) AND WHITE RIVER BELOW ASPHALT WASH (S-11)

OCTOBER 1975 - SEPTEMBER 1976

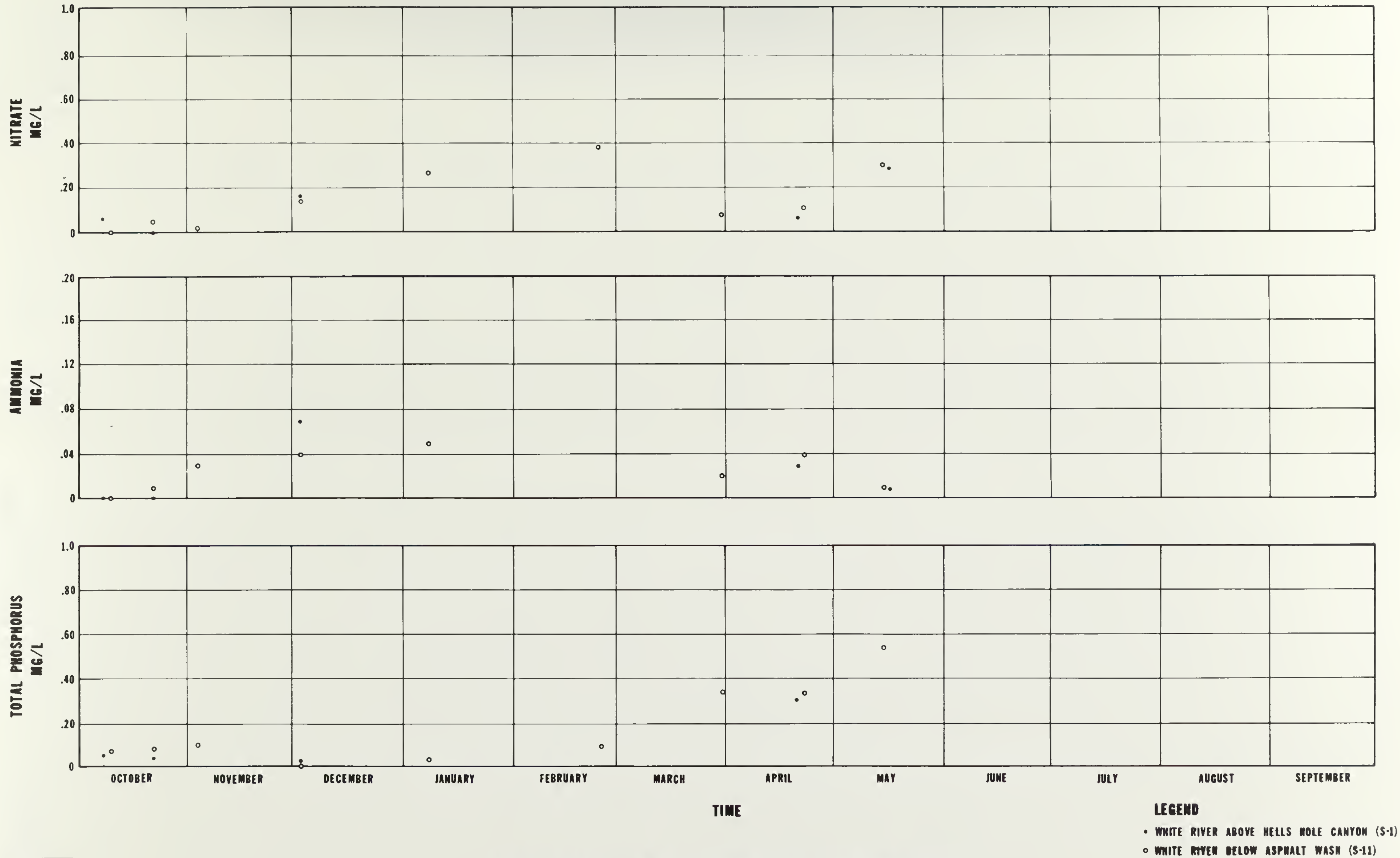
FIGURE II-2



VARIATION IN TIME OF MAJOR ANIONS

WHITE RIVER ABOVE HELLS HOLE CANYON (S-1) AND WHITE RIVER BELOW ASPHALT WASH (S-11)
OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-3



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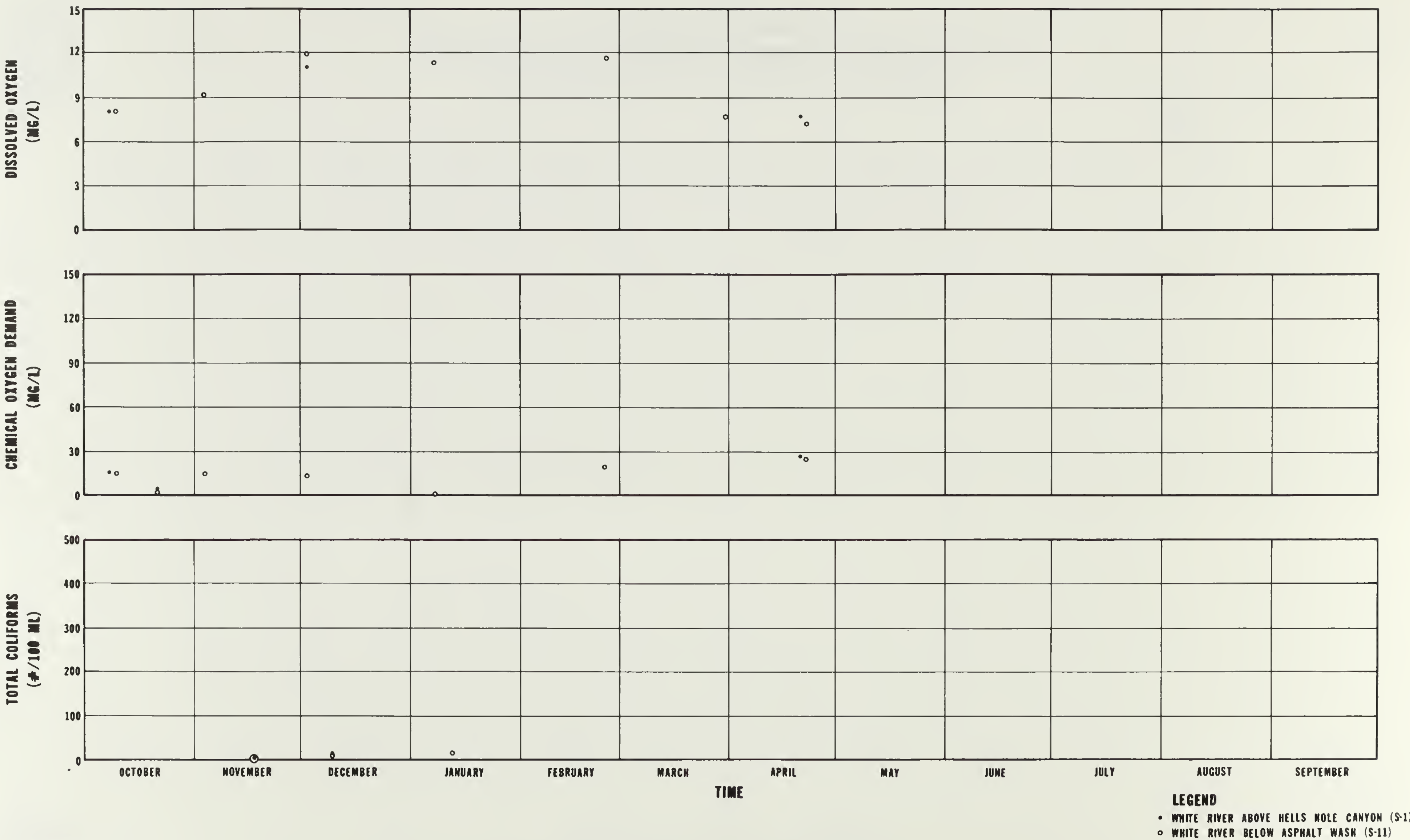
VARIATION IN TIME OF REPRESENTATIVE NUTRIENTS

WHITE RIVER ABOVE HELLS HOLE CANYON (S-1) AND WHITE RIVER BELOW ASPHALT WASH (S-11)

OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-4

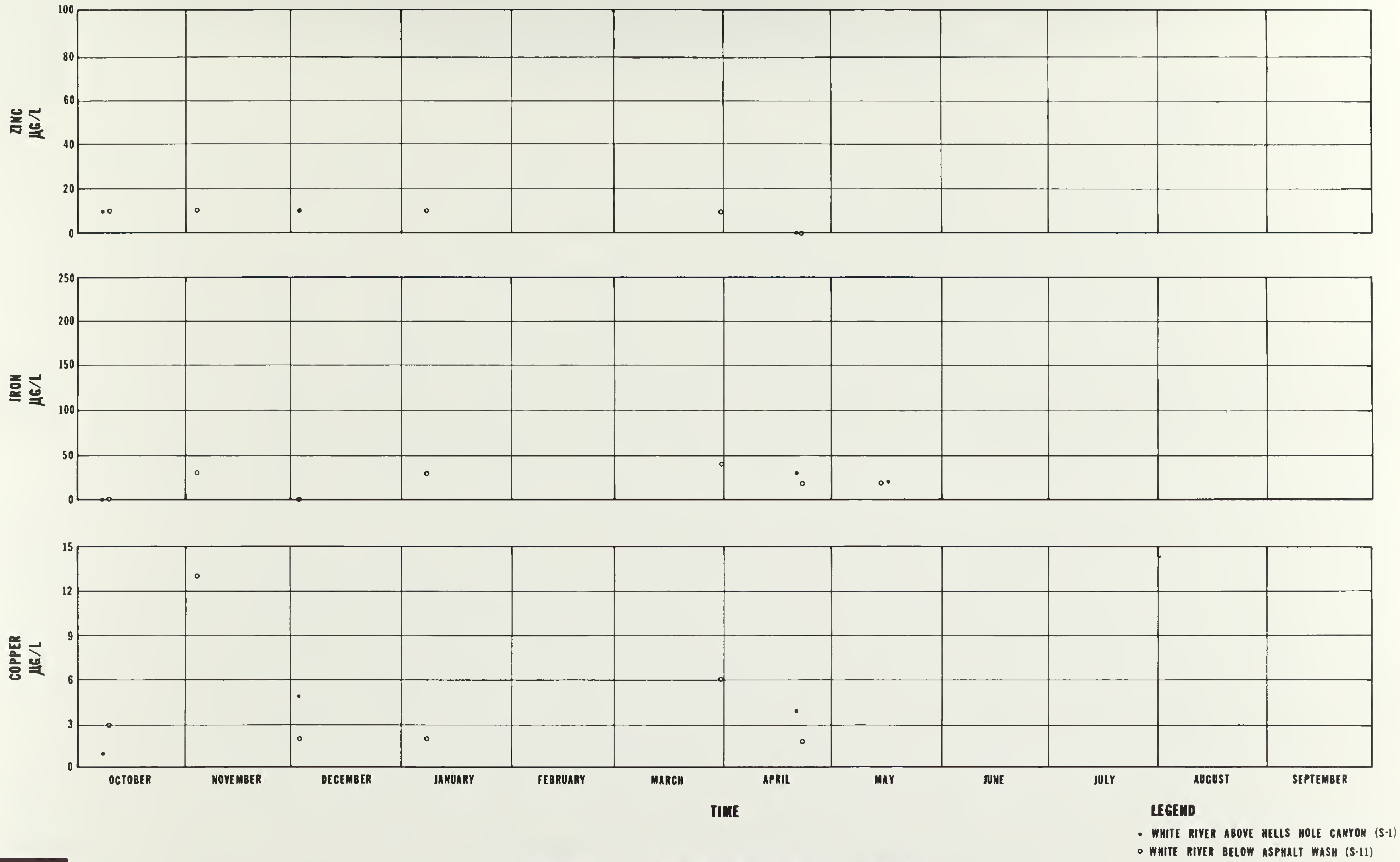


VARIATION IN TIME OF BIOCHEMICAL CONSTITUENTS

WHITE RIVER ABOVE HELLS HOLE CANYON (S-1) AND WHITE RIVER BELOW ASPHALT WASH (S-11)

OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-5

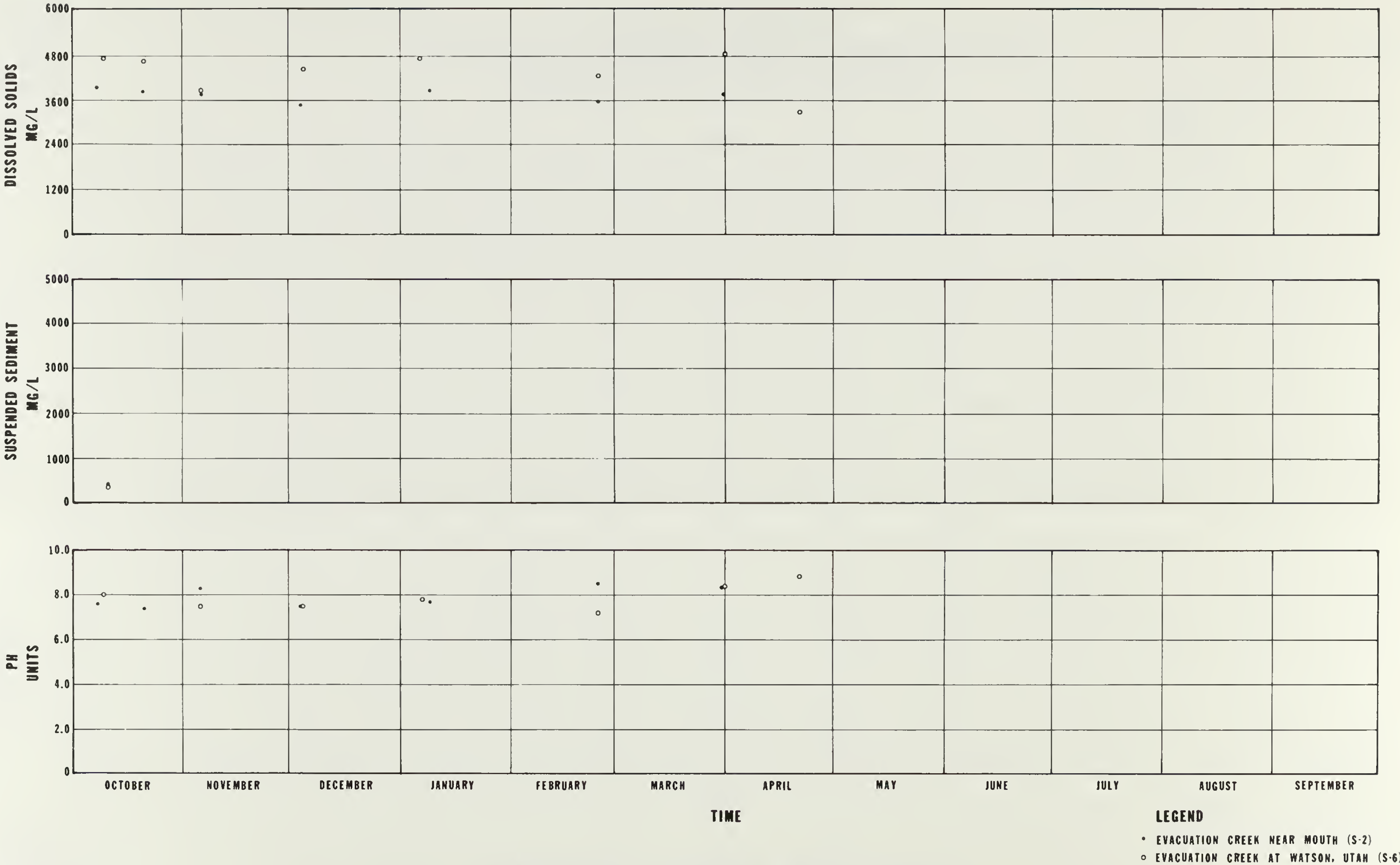


VARIATION IN TIME OF SOME TRACE ELEMENTS

WHITE RIVER ABOVE HELLS HOLE CANYON (S-1) AND WHITE RIVER BELOW ASPHALT WASH (S-11)

OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-6

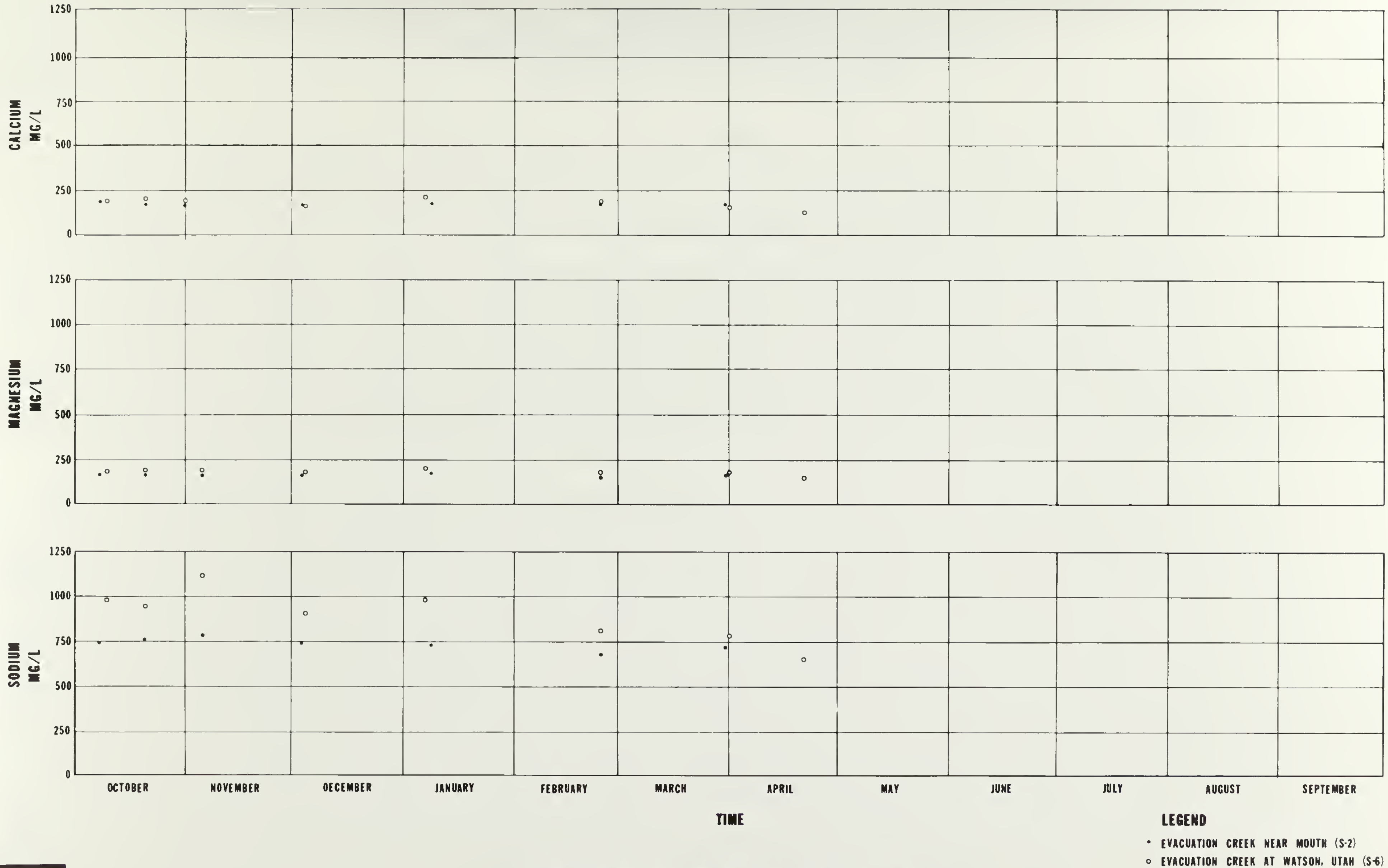


VARIATION OF GENERAL CHARACTERISTICS

EVACUATION CREEK NEAR MOUTH (S-2) AND EVACUATION CREEK AT WATSON, UTAH (S-6)

OCTOBER 1975 - SEPTEMBER 1976

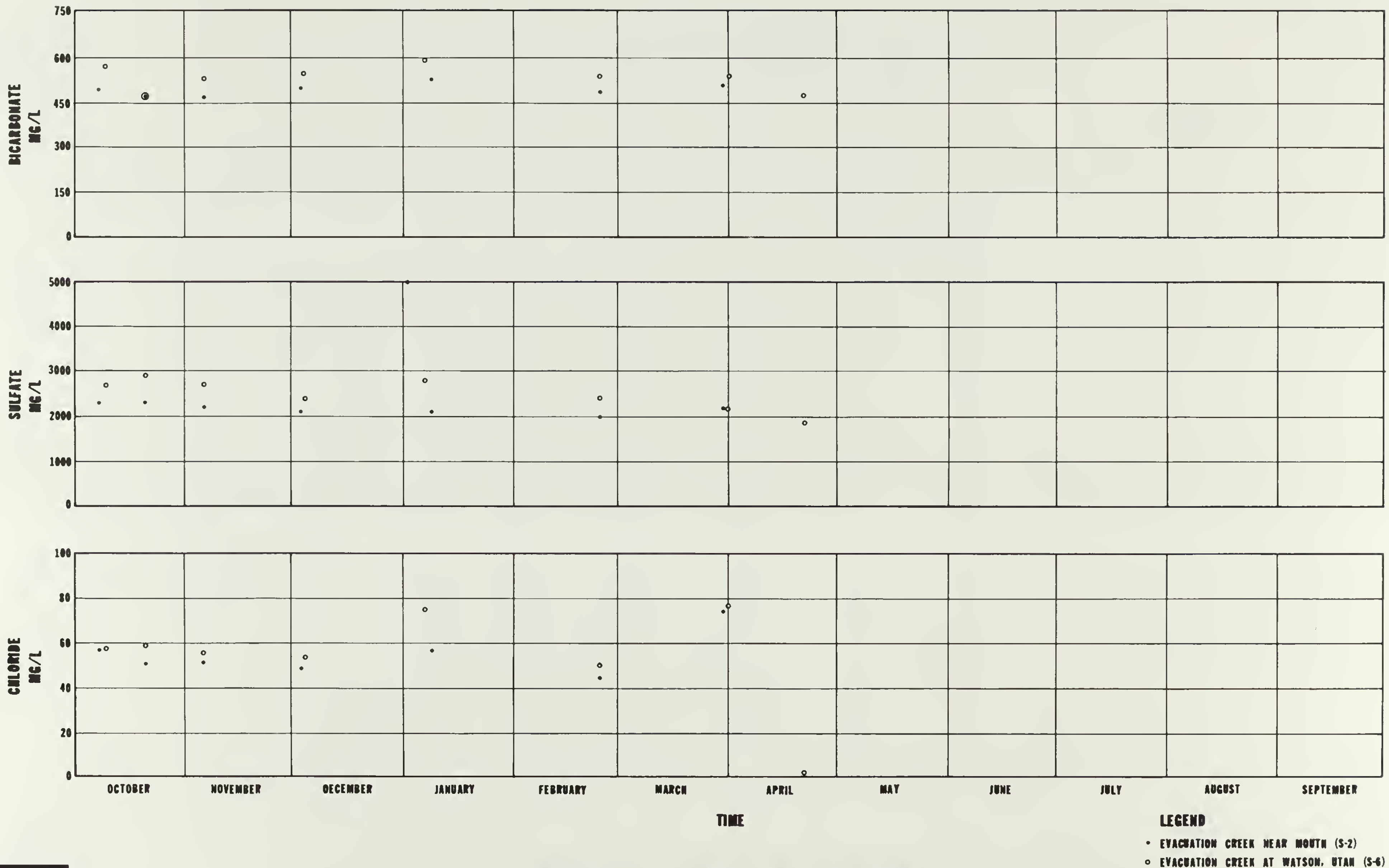
FIGURE II-7



VARIATION IN TIME OF MAJOR CATIONS

EVACUATION CREEK NEAR MOUTH (S-2) AND EVACUATION CREEK AT WATSON, UTAH (S-6)
OCTOBER 1975 - SEPTEMBER 1976

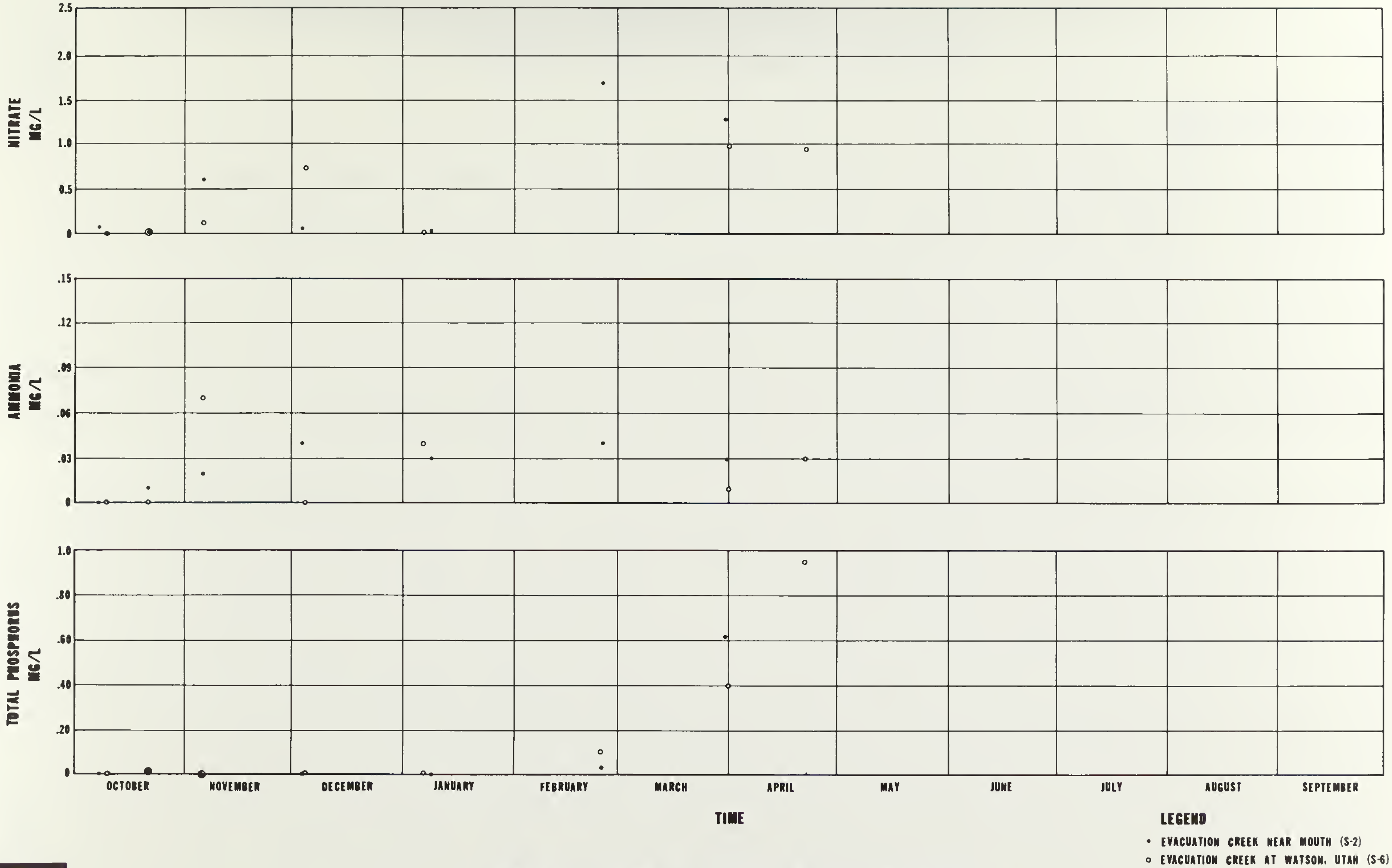
FIGURE II-8



VARIATION IN TIME OF MAJOR ANIONS

EVACUATION CREEK NEAR MOUTH (S-2) AND EVACUATION CREEK AT WATSON, UTAH (S-6)
OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-9

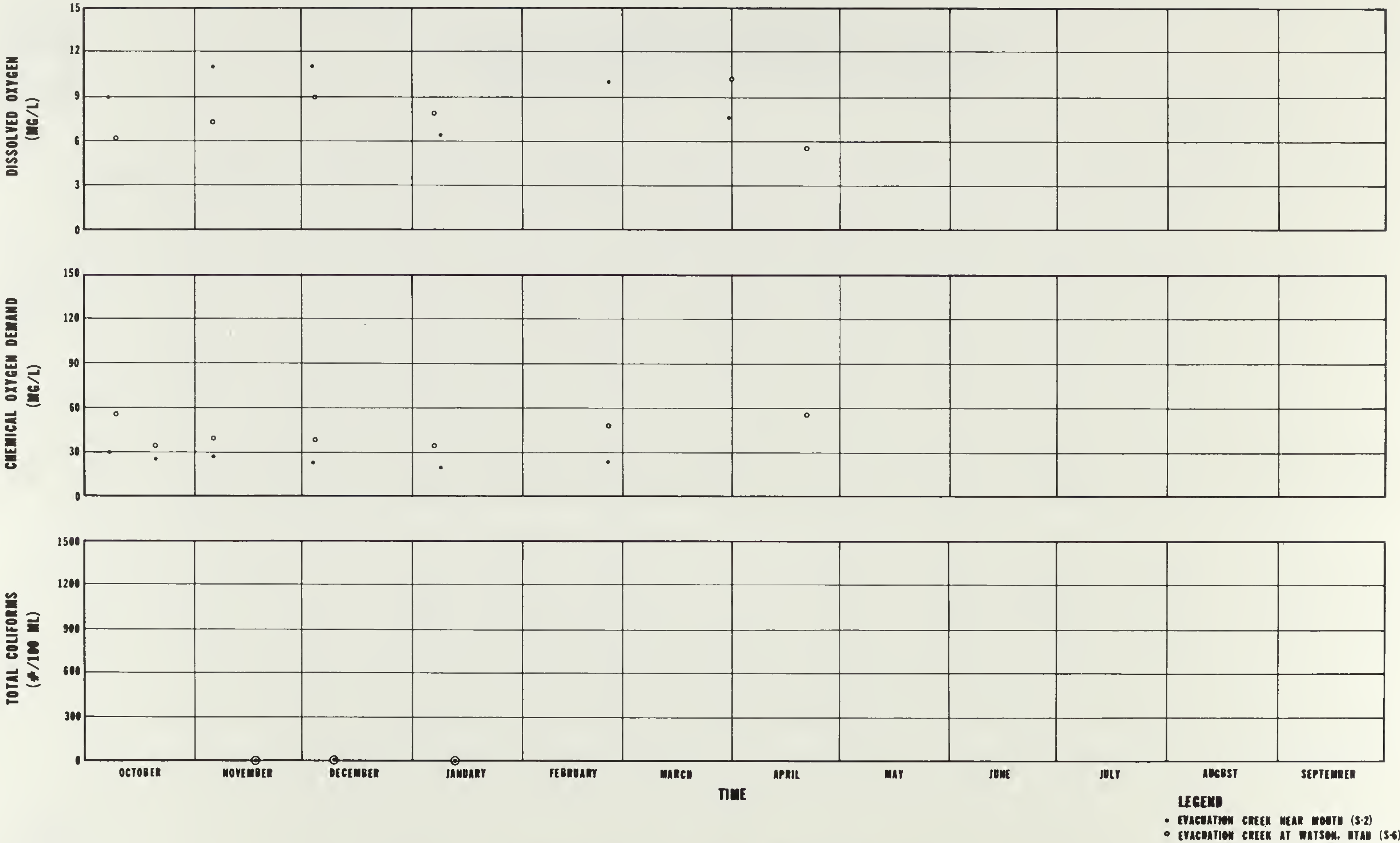


VARIATION IN TIME OF REPRESENTATIVE NUTRIENTS

EVACUATION CREEK NEAR MOUTH (S-2) AND EVACUATION CREEK AT WATSON, UTAH (S-6)

OCTOBER 1975 - SEPTEMBER 1976

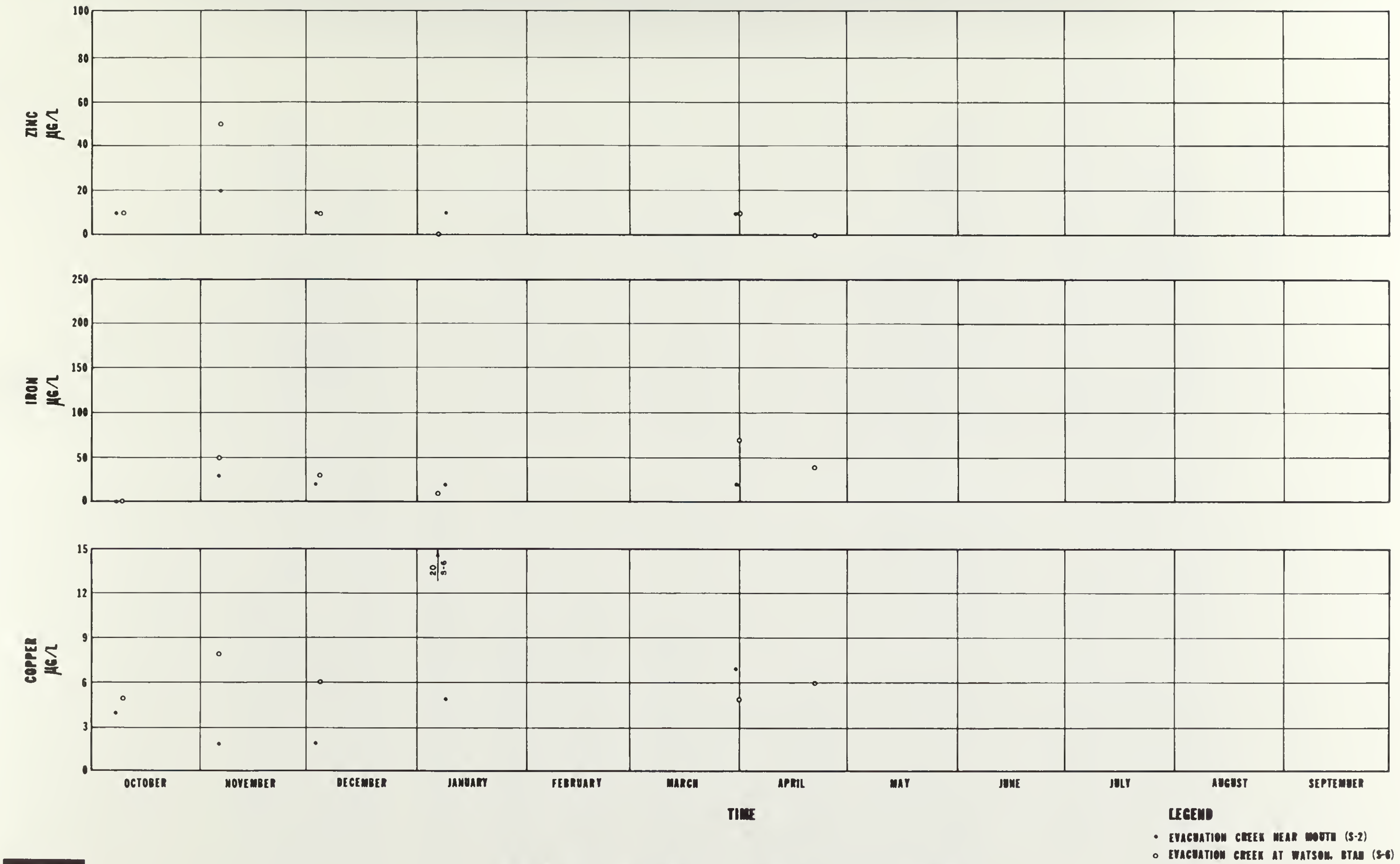
FIGURE II-10



VARIATION IN TIME OF BIOCHEMICAL CONSTITUENTS

EVACUATION CREEK NEAR MOUTH (S-2) AND EVACUATION CREEK AT WATSON, UTAH (S-6)
OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-11



VARIATION IN TIME OF SOME TRACE ELEMENTS

EVACUATION CREEK NEAR MOUTH (S-2) AND EVACUATION CREEK AT WATSON, UTAH (S-6)

OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-12

3. GROUND WATER LEVEL MONITORING

The continuous well hydrographs will be updated and included in the next quarterly report. Static measurements collected this quarter are shown on Figure II-13. The slight downward trend beginning in early to mid-March in most wells continued through the quarter.

4. GROUND WATER QUALITY

No data are available this quarter from the USGS laboratories for samples of alluvial well water collected and submitted during the quarter. The pumped samples collected from the bedrock aquifer wells in March were submitted to a private lab, and the results are reported in the field data.

C. WORK SCHEDULED

1. SURFACE WATER

Monitoring will continue as stipulated in the revised Conditions of Approval.

2. SURFACE WATER QUALITY

Monitoring will continue as stipulated in the revised Conditions of Approval.

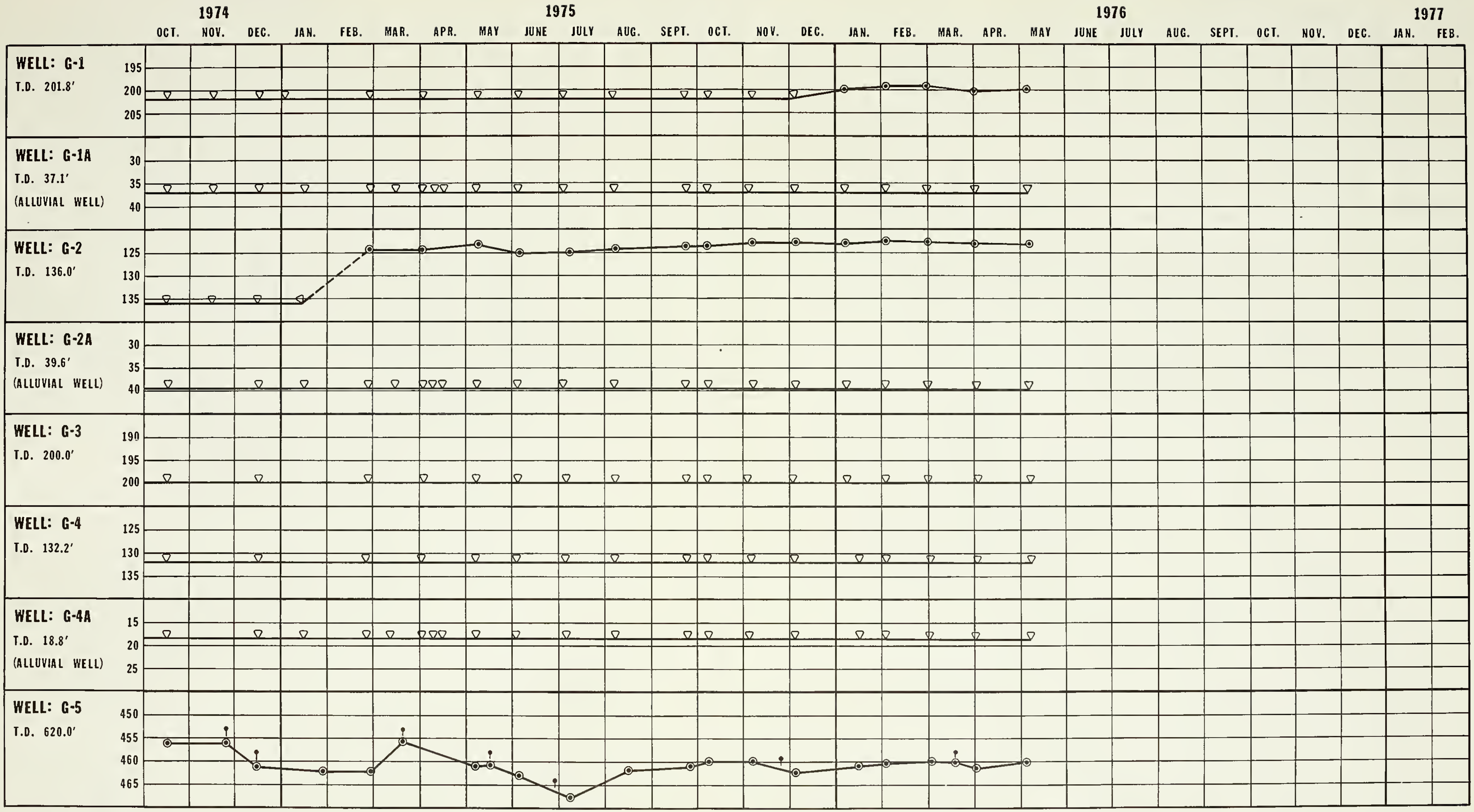
3. GROUND WATER LEVEL MONITORING

Water levels will be measured monthly in all wells and will be recorded continuously at the P-1, P-2 upper, and P-2 lower sites of record. Delays in the delivery of replacement parts will probably mean the loss of the P-3 continuous record, so static levels will be taken several times monthly until repairs can be made.

4. GROUND WATER QUALITY

Semi-annual pumped samples will be collected from all bedrock aquifer wells in June and will be submitted for analysis to the USGS labs in Atlanta, Georgia.

Semi-annual alluvial well samples will be collected from all wells containing water in June and from all lower and single wells in July and August.

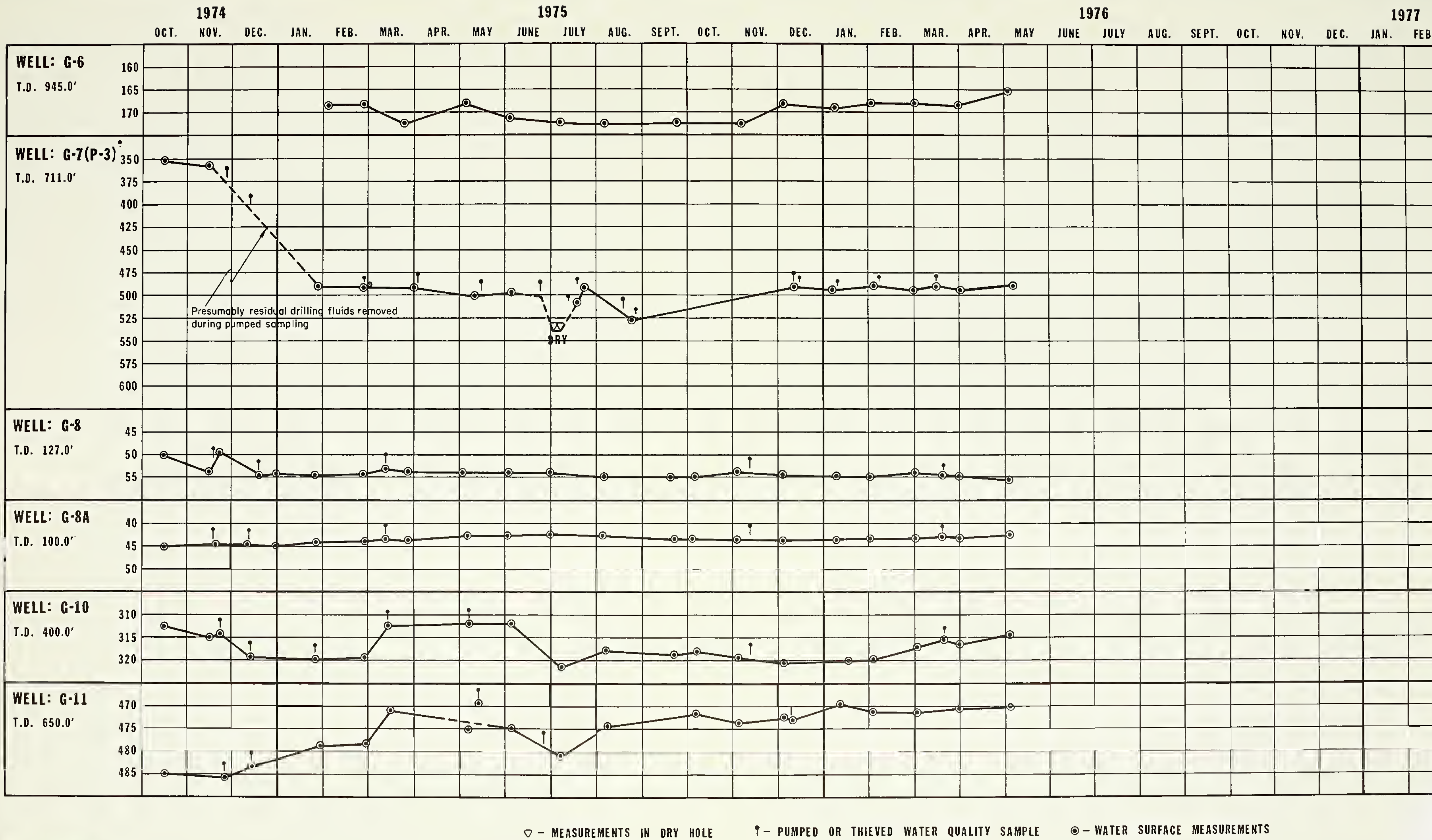


▽ – MEASUREMENTS IN DRY HOLE ↑ – PUMPED OR THIEVED WATER QUALITY SAMPLE ⊙ – WATER SURFACE MEASUREMENTS

MONTHLY MEASURED STATIC WATER LEVELS IN WELLS

WHITE RIVER SHALE PROJECT TRACTS Ua & Ub

FIGURE II-13



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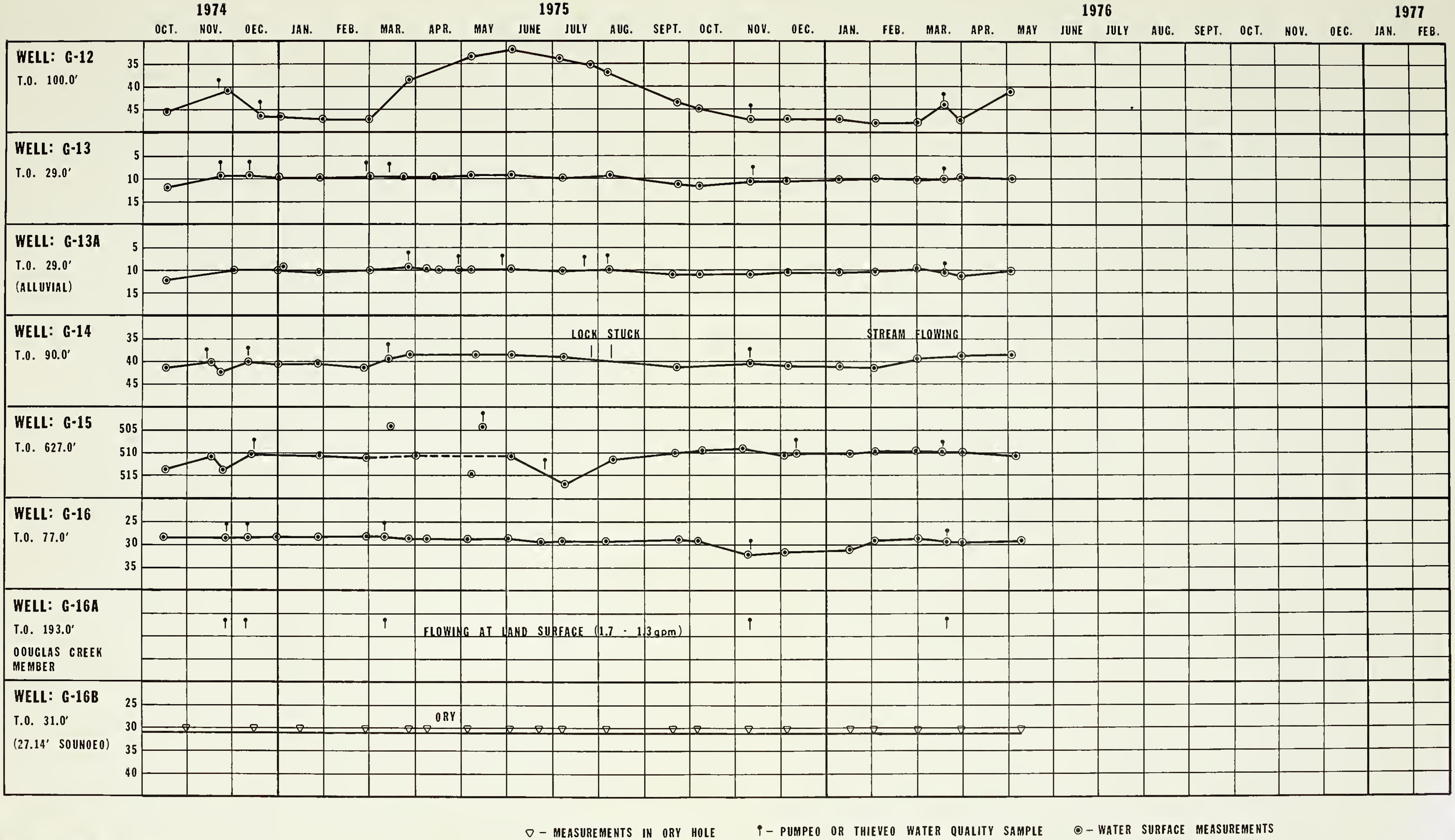
MONTHLY MEASURED STATIC WATER LEVELS IN WELLS

WHITE RIVER SHALE PROJECT TRACTS Ua & Ub

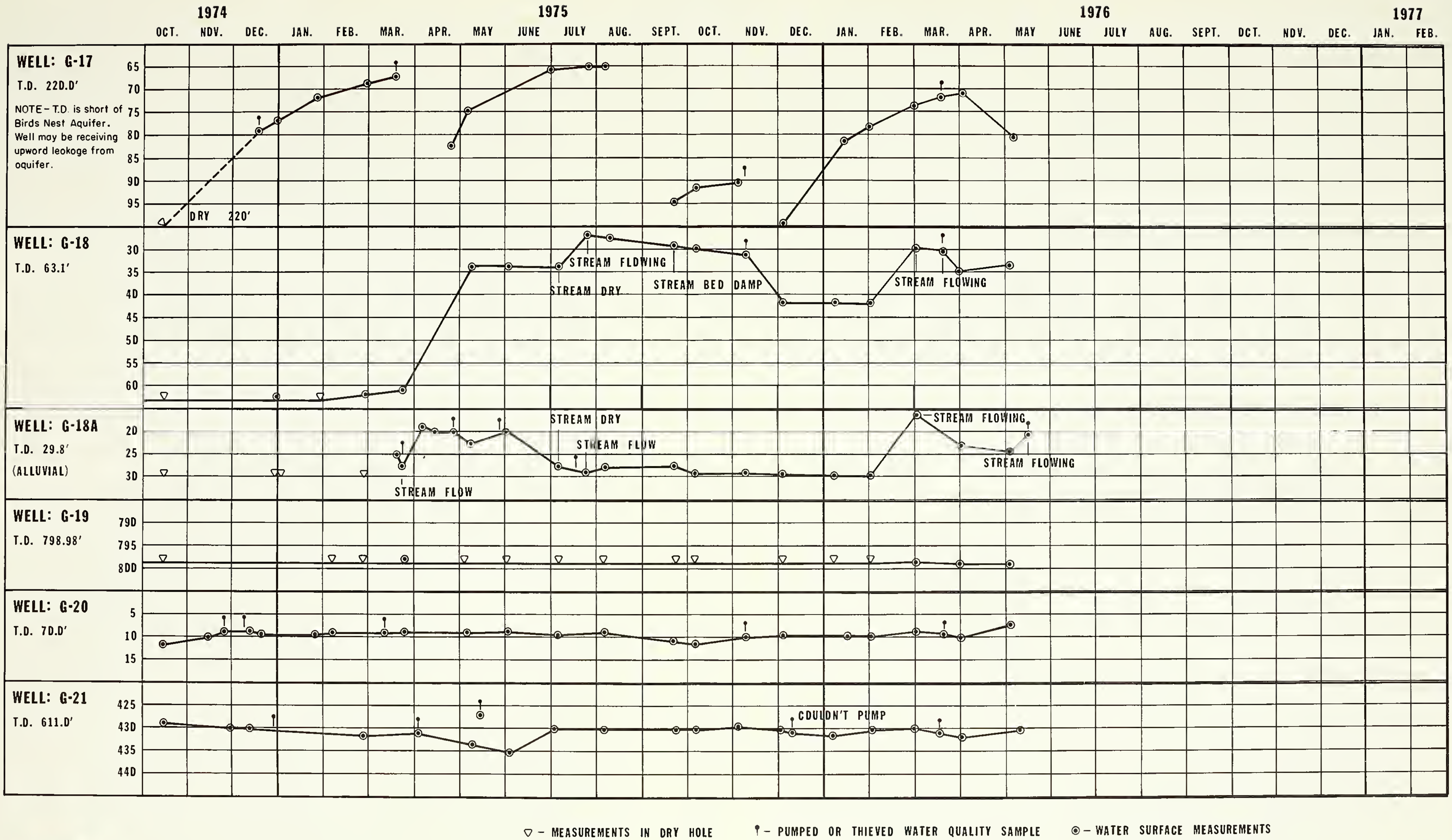
FIGURE II-13 (CON'T)



MONTHLY MEASURED STATIC WATER LEVELS IN WELLS

WHITE RIVER SHALE PROJECT TRACTS Ua & Ub

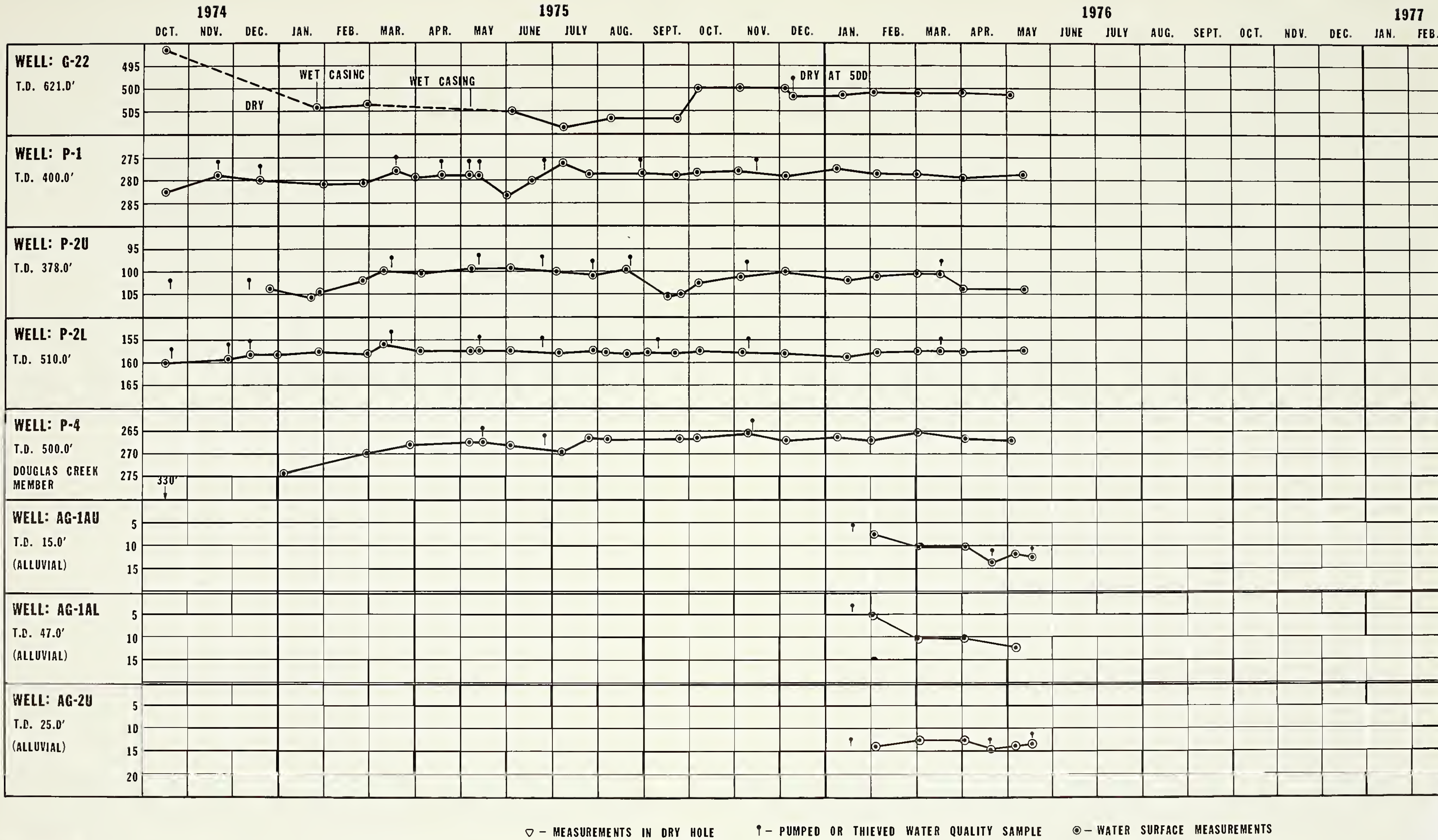
FIGURE II-13 (CON'T)



MONTHLY MEASURED STATIC WATER LEVELS IN WELLS

WHITE RIVER SHALE PROJECT TRACTS Ua & Ub

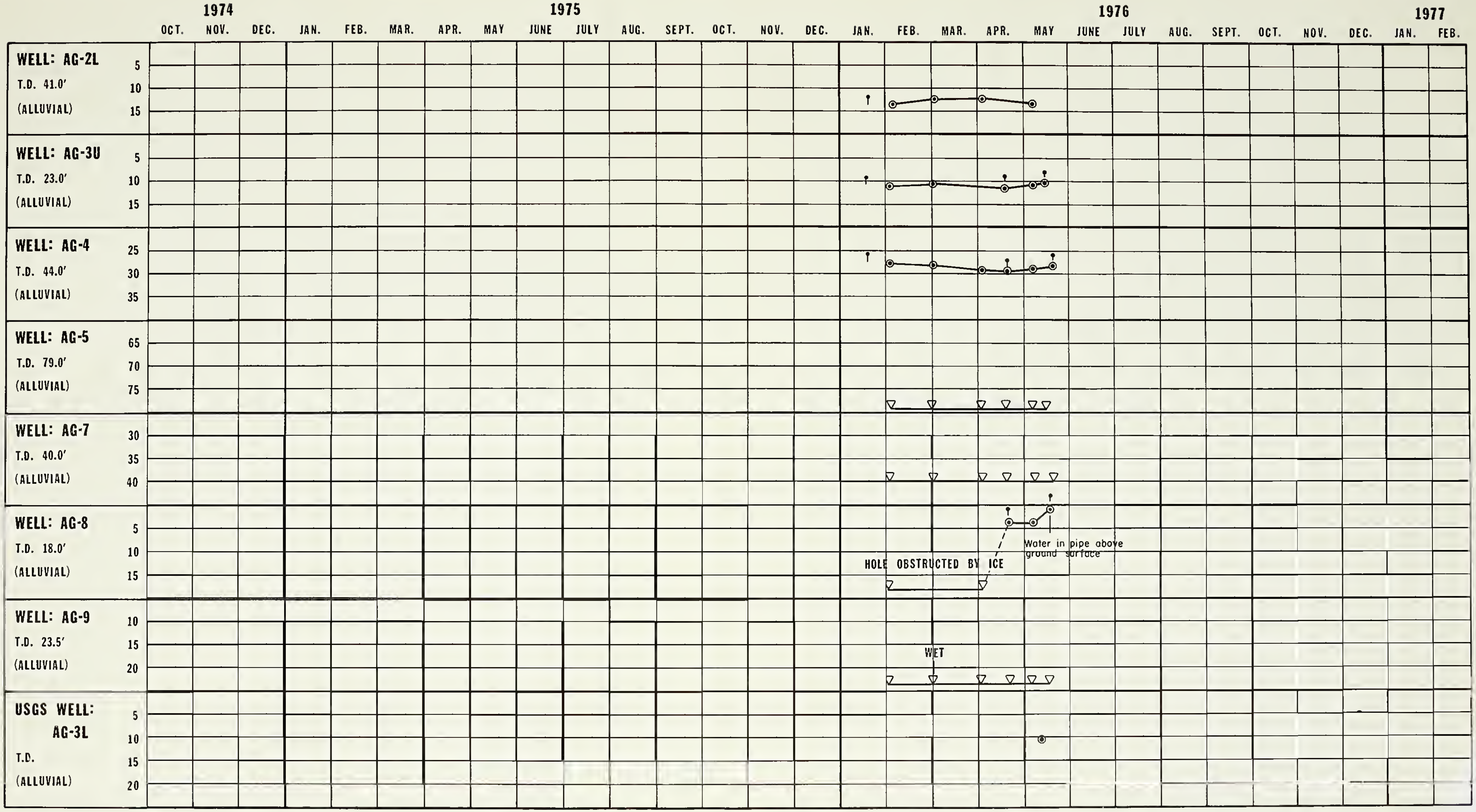
FIGURE II-13 (CON'T)



MONTHLY MEASURED STATIC WATER LEVELS IN WELLS

WHITE RIVER SHALE PROJECT TRACTS Ua & Ub

FIGURE II-13 (CON'T)

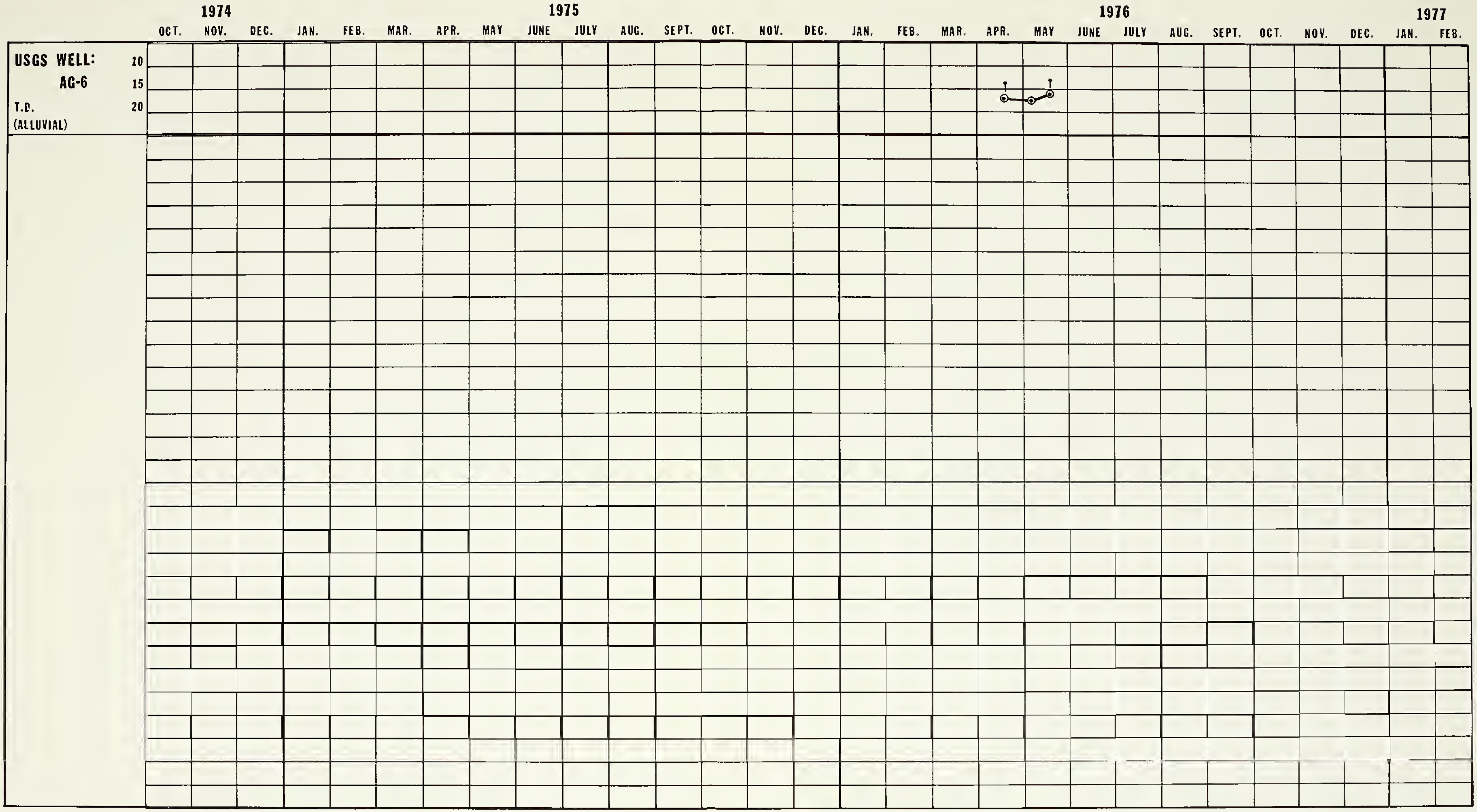


▽ – MEASUREMENTS IN DRY HOLE † – PUMPED OR THIEVED WATER QUALITY SAMPLE ⊙ – WATER SURFACE MEASUREMENTS

MONTHLY MEASURED STATIC WATER LEVELS IN WELLS

WHITE RIVER SHALE PROJECT TRACTS Ua & Ub

FIGURE II-13 (CON'T.)



▽ – MEASUREMENTS IN DRY HOLE ⍑ – PUMPED OR THIEVED WATER QUALITY SAMPLE ⊙ – WATER SURFACE MEASUREMENTS

MONTHLY MEASURED STATIC WATER LEVELS IN WELLS

WHITE RIVER SHALE PROJECT TRACTS Ua & Ub

FIGURE II-13(CON'T)

III. AIR RESOURCES

A. WORK COMPLETED

During the quarter ending May 31, 1976, meteorology, air quality, radiation, and sound level monitoring continued as stipulated in the provisions of the leases or as prescribed by the Conditions of Approval for the environmental baseline monitoring program. Certain additional supporting measurements were also made at the request of the lease operators.

After the first year of baseline monitoring, the air resources program modifications for the second year of baseline data collection were proposed to the Area Oil Shale Supervisor (AOSS). These modifications were approved April 14 and implemented in May. They include--

1. Suspension of required air quality monitoring (H_2S, SO_2 and particulates) at Station A-1, which is some distance upwind from the tract and has provided only redundant data.

2. Suspension of required air quality monitoring (SO_2, H_2S, particulates, NO/NO_x, O_3, HC and CO) at Station A-2 because of data redundancy.

3. Partial suspension of required air quality monitoring (CO, HC, NO/NO_x and O_3) at Station A-3 because of data redundancy, but retention of SO_2/H_2S and suspended particulate monitoring.

4. Suspension of required air quality monitoring (SO_2, H_2S and particulates) at Station A-5 because of data redundancy.

5. Suspension of required air quality monitoring (SO_2, H_2S and particulates) at Station A-8 because of redundant data and distance from likely impact areas.

6. Suspension of wind speed/direction monitoring at stations A-1, A-5, A-8, A-9 and A-12 because of sufficient background data and because these sites are outside the area of interest relevant to probable plant siting.

7. Elimination of temperature measurements at stations A-9 and A-12.

8. Construction of a new anemometer (Station A-13) located in the northeast quarter of Section 22 in Tract U-a to define more closely drainage flows in the general vicinity of the proposed plant site.

9. Maintenance of CO, HC, NO/NO_x and O_3 equipment at Station A-2 on stand-by to be placed in operation if any or all of same equipment at Station A-6 becomes inoperative and cannot be repaired in a reasonable period of time.

With the exception of these changes, all measurement activities continued on the schedule of continuous or regular measurements established previously. All air monitoring instruments were calibrated in May. In addition to the regular quarterly calibrations of the gaseous pollutant analyzers and the twice-annual high-volume sampler calibrations, more frequent zero and span checks are made for most air pollutant instruments.

The extent of the data collected during the three-month period from February 1, 1976 through April 30, 1976, is tabulated on Table III-1. (Data processing lead times result in a one-month offset from the March-May quarter reporting period for most of the data in this discussion.) This table lists the percentage of hours spent on data collection during this period for each parameter. Calibration time is counted as data collection time. Only the parameters specifically listed in the leases (or implied therein) are tabulated. The leases state that ". . .the Lessee shall monitor air quality over at least 90 percent of each lease year,. . . using four strategically located stations (per tract)." Table III-1 shows that air quality monitoring took place 100% of the February-April period, while monitoring of each of the specified parameters also occurred 100% of the hours of this period. For meteorology, the leases state that ". . .the Lessee shall establish a meteorological station. . . to monitor, at least 95 percent of the time over each lease year" various meteorological parameters. Again, meteorological monitoring was conducted 100% of this February-April period at a number of stations well in excess of the one per tract specified in the leases, and monitoring of any given parameter was performed at least 98% of the hours of this quarter.

B. DATA SUMMARY

In general, conditions observed on the tracts during this period compare well with those in 1975.

TABLE III-1

PERCENTAGE OF TIME MONITORING WAS PERFORMED
DURING THE PERIOD FEBRUARY 1, 1976 - APRIL 30, 1976

Component	Number of Stations	Percentage
H_2S	8	100
SO_2	8	100
Susp. Particulates	8	100
HC	3	100
NO_x	3	100
O_3	8	100
Wind (10 m)	12	100
Wind (20 m)	2	100
Wind (30 m)	2	98
Temp. (10 m)	7	100
Δ Temp. (30-10 m)	2	100
Rel. Hum. (10 m)	2	100

1. METEOROLOGY

a. Surface Meteorology

Typical airflow patterns observed on the tracts during the early morning (0400-0700 MST) and afternoon (1400-1600 MST) in this quarter are shown on figures III-1 and III-2. The solid arrows in these figures are wind vectors at monitoring sites, and the longer lines are estimated flow streamlines. In the early morning hours, airflow was of the drainage type, flowing toward low terrain and down the White River channel. This phenomenon has been observed throughout the monitoring program. The afternoon winds were more organized and were dominated by the synoptic scale pressure gradient. A general west-to-east airflow pattern can be recognized throughout the tracts. Just east of Evacuation Creek, there was a general northerly wind flow.

The diurnal variation of mean wind speed and its standard deviation at Station A-2 in April are plotted on Figure III-3. (The usual data at Station A-6 was not used because calibration factors were not available at the time this report was prepared.) High winds were observed in the afternoon and low winds at night. In the afternoon, winds averaged 5 m/s (11 mph), while at night winds averaged 2 m/s (4.5 mph). Figure III-4 presents directional wind roses at all wind stations on the tracts. The predominance of drainage type of winds is clearly shown.

Spatial variation in wind speed and wind direction over the tracts is evident in figures III-1, III-2 and III-4. This is a consequence of the complicated terrain features in the area. Generally, wind speeds over the ridges and widely exposed terrain were higher than wind speeds in protected valleys.

Figure III-5 presents the diurnal variation in temperature in April at Station A-6. Average nighttime values were around 4°C (39°F), and average afternoon values were around 13°C (55°F). The daily maximum temperature was generally observed at 1400-1500 MST, while the daily minimum temperature was observed between 0400-0600 MST. On the tracts, temperatures were usually lower in protected valleys than in open terrain.

A plot of the diurnal variation in relative humidity in April at Station A-6 is shown on Figure III-6. Nighttime relative humidity was about 65%, and the afternoon relative humidity was about 35%. This diurnal trend is a mirror

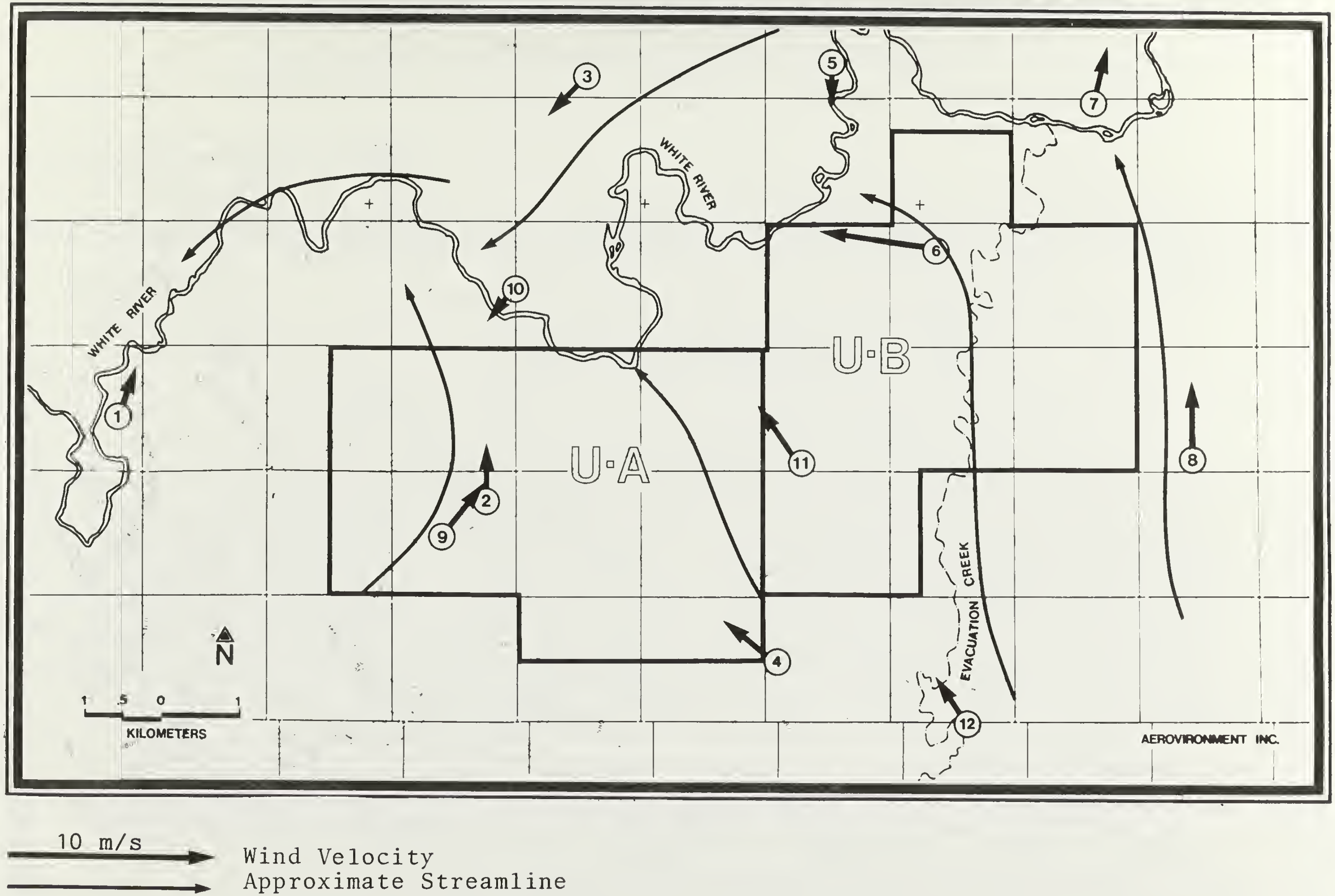


FIGURE III-1. TYPICAL AIRFLOW PATTERN ON TRACTS U-a AND U-b IN THE MORNING IN APRIL 1976.

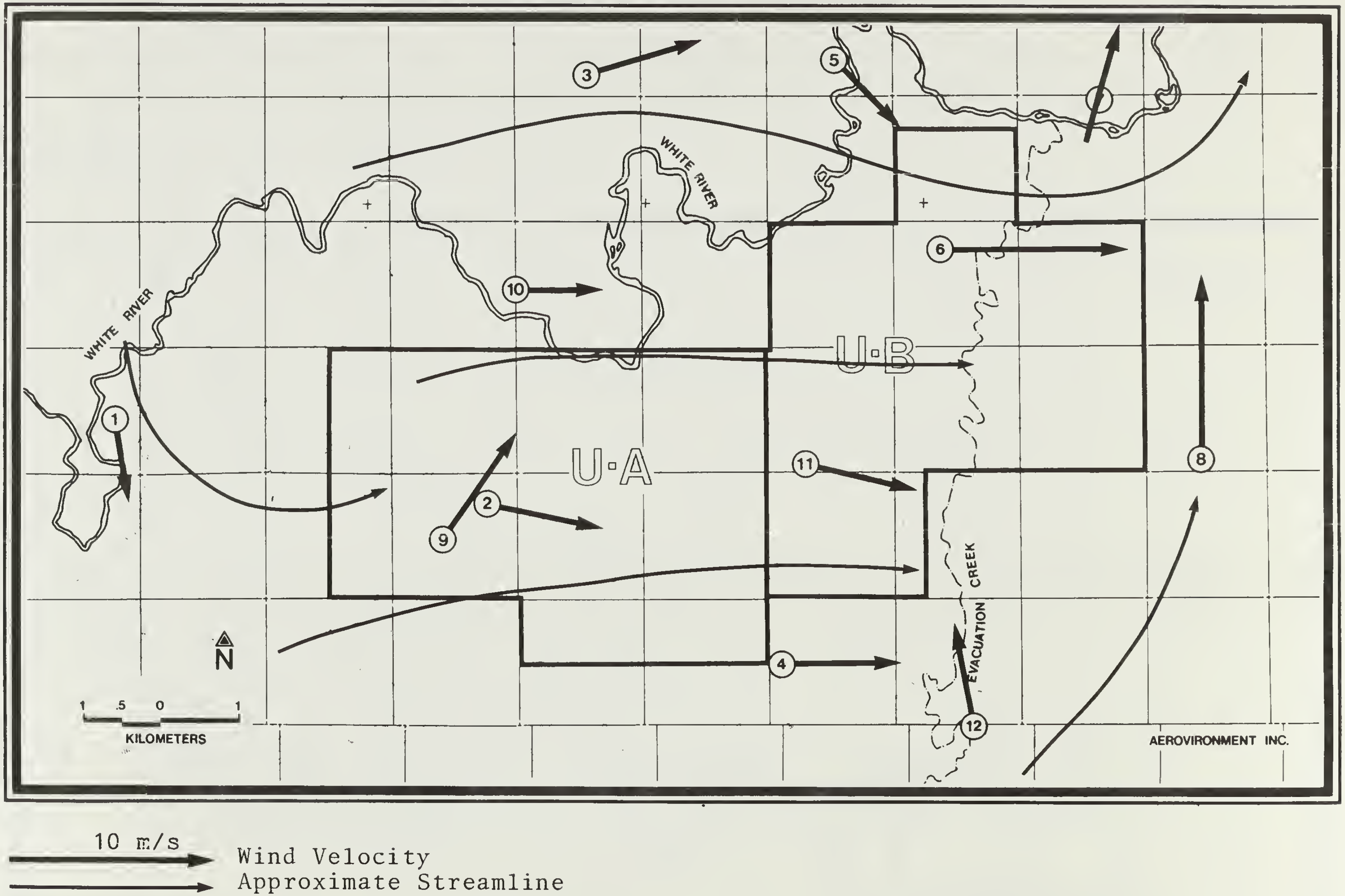


FIGURE III-2. TYPICAL AIRFLOW PATTERN ON TRACTS U-a AND U-b IN THE AFTERNOON IN APRIL 1976.

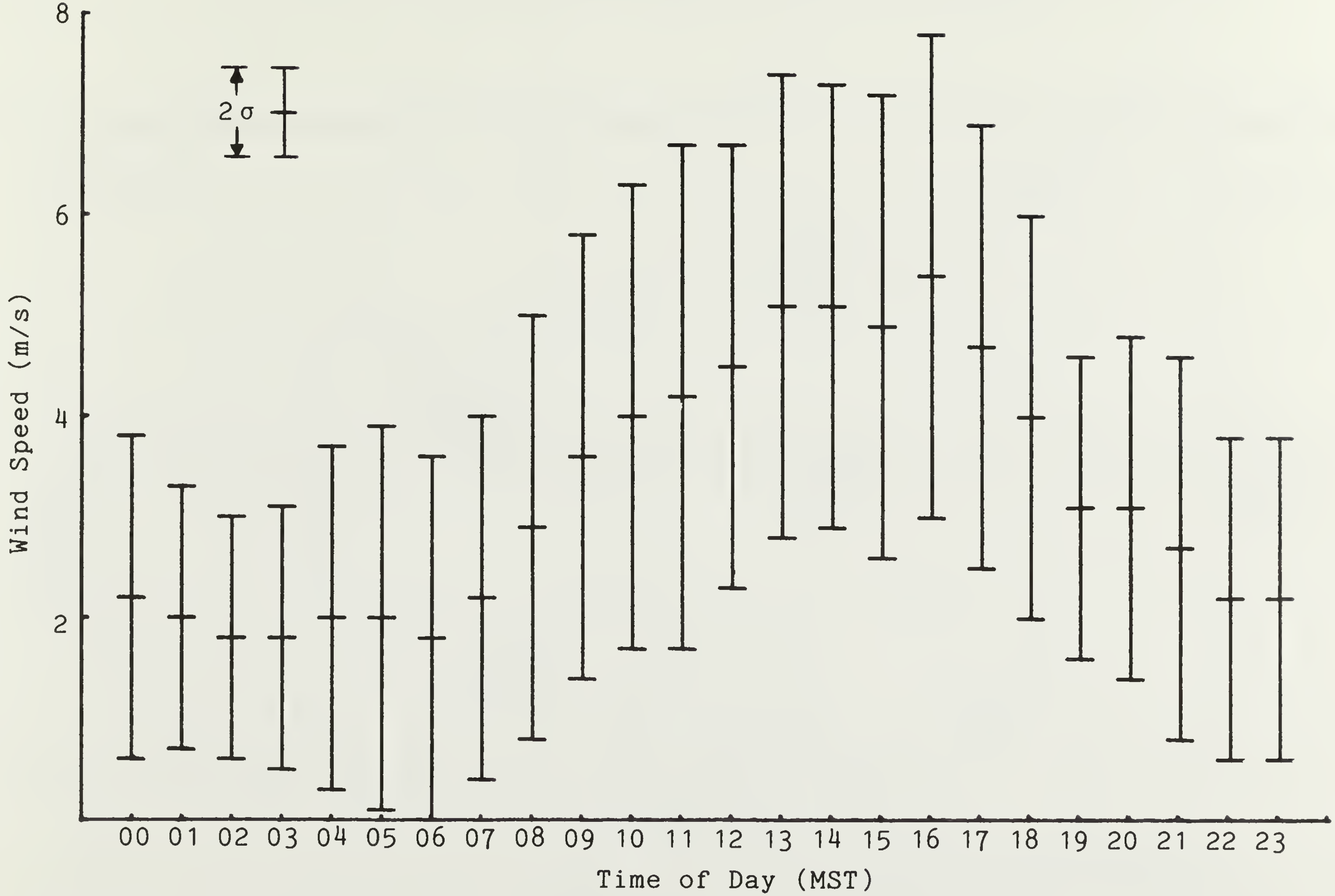


FIGURE III-3. DIURNAL VARIATION OF MEAN WIND SPEEDS AND THEIR STANDARD DEVIATIONS AT STATION A-2 IN APRIL 1976, A TYPICAL SPRING MONTH. (1 m/s = 2.2 mph)

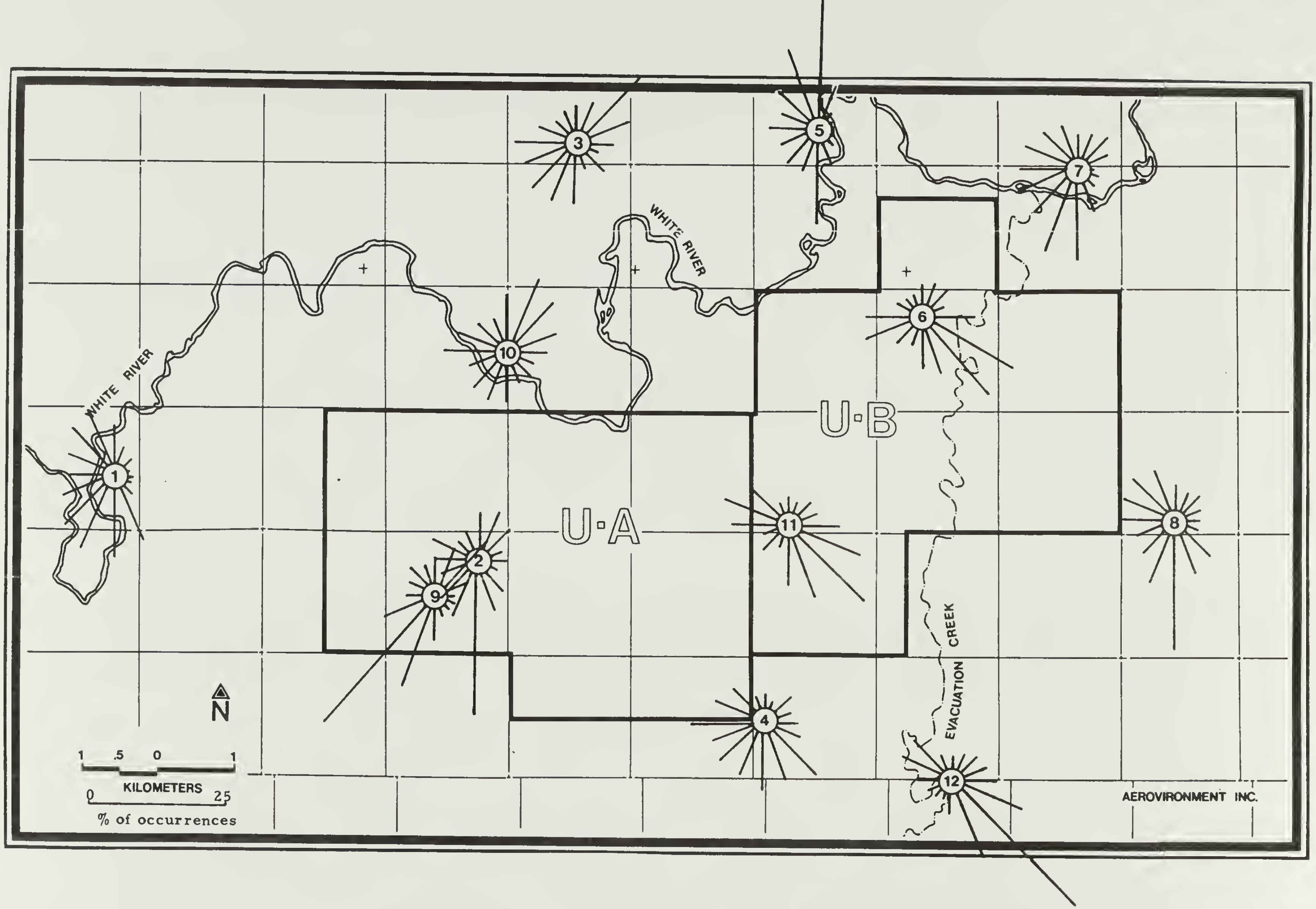


FIGURE III-4. DIRECTIONAL WIND ROSES AT THE MONITORING STATIONS ON THE TRACTS FOR APRIL 1976. The length of each bar represents the frequency of winds from the direction toward which the bar points.

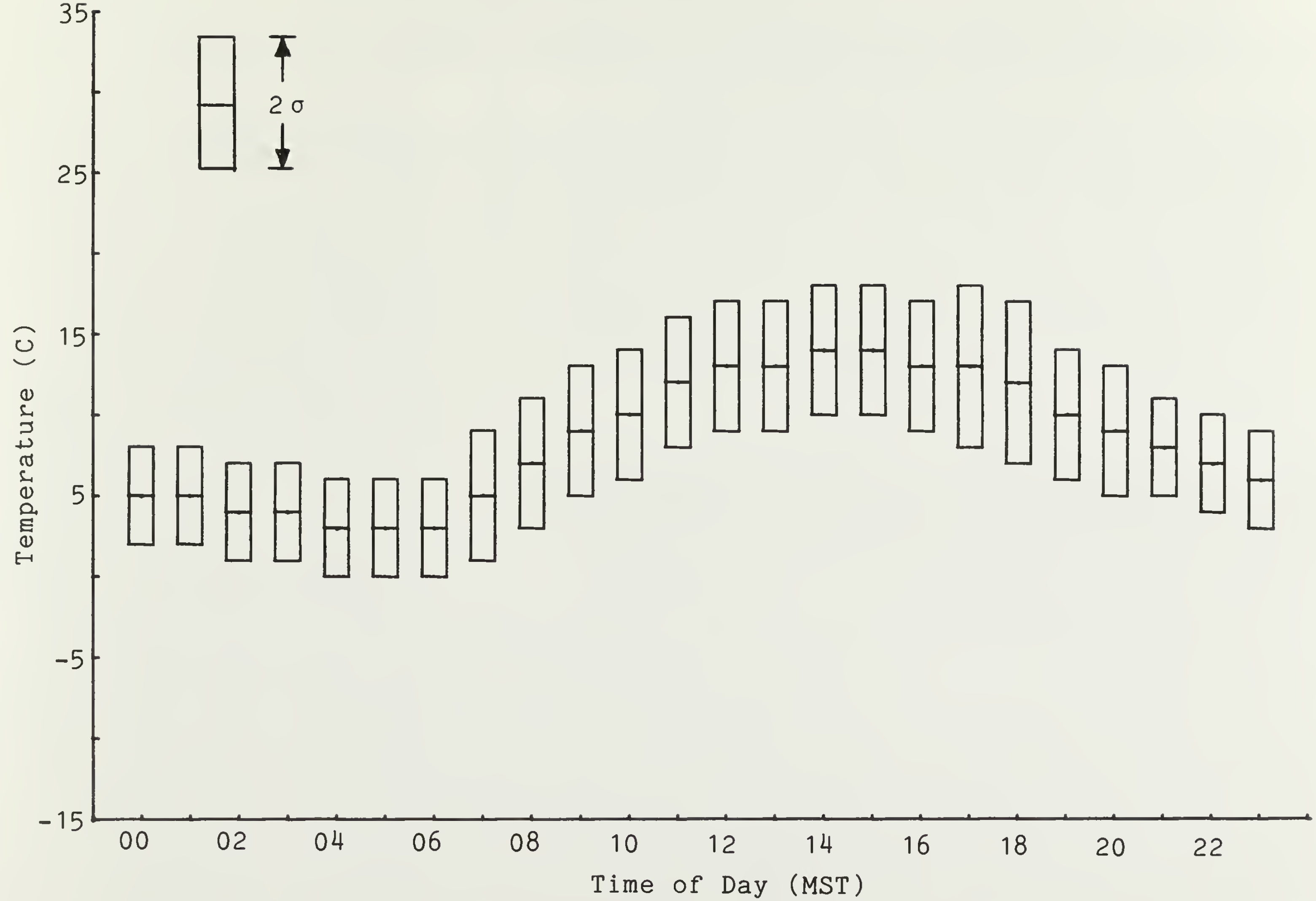


FIGURE III-5. DIURNAL VARIATION OF MEAN TEMPERATURES AND THEIR STANDARD DEVIATIONS AT STATION A-6 IN APRIL 1976. Multiply values by 1.8 and add 32 to get °F.

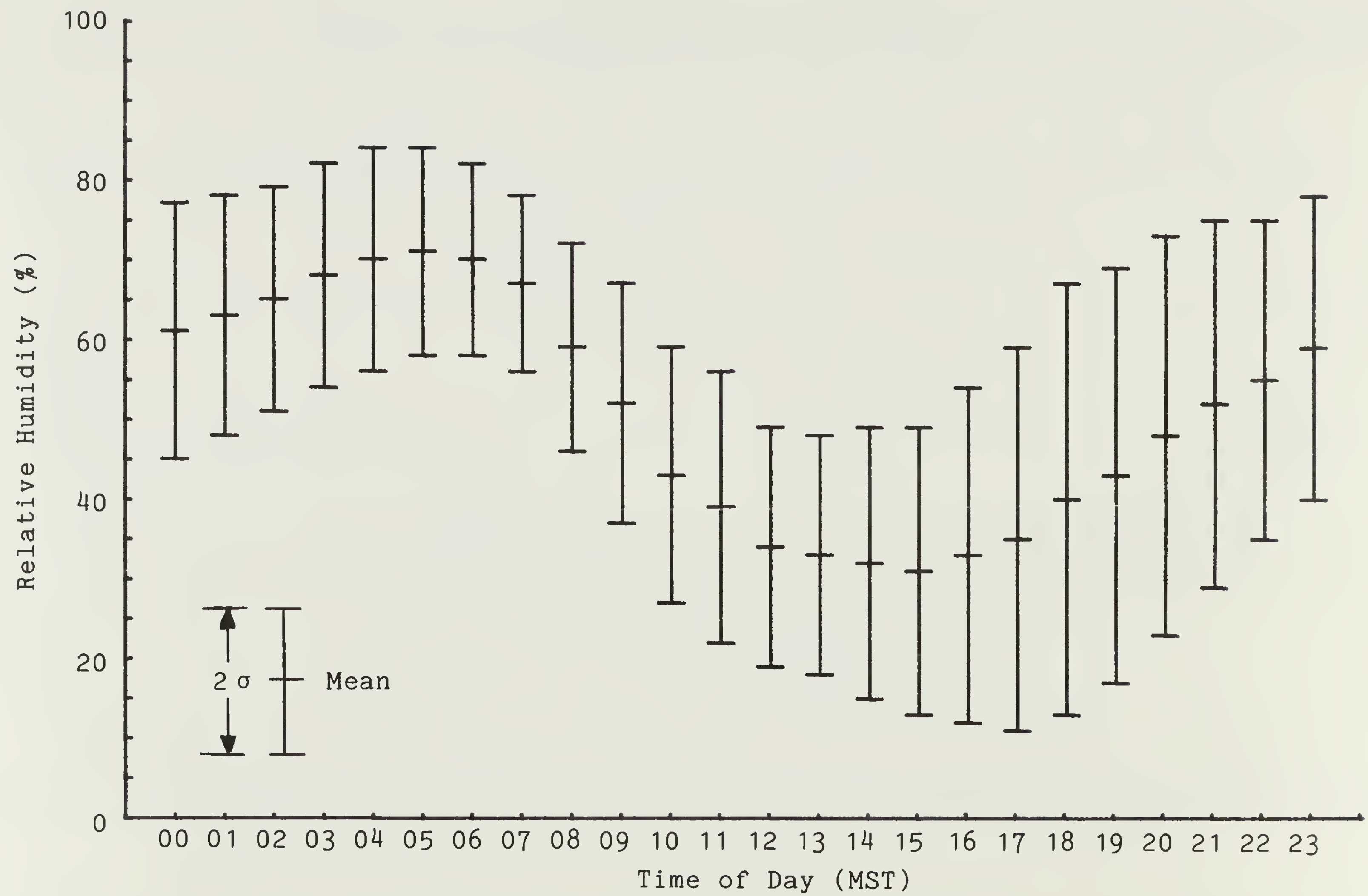


FIGURE III-6. DIRUNAL VARIATION OF MEAN RELATIVE HUMIDITY READINGS AND THEIR STANDARD DEVIATIONS AT STATION A-6 DURING APRIL 1976.

image of the temperature plot in Figure III-5, which indicates that the amount of water vapor in the air remains constant during the day.

b. Normality of Measurement Period

This section is an analysis of the normality of meteorological conditions on the tracts by comparing rawinsonde data collected by the National Weather Service at Grand Junction during the monitoring program with corresponding historical meteorological records. Since there is a six-month delay between upper-air data collection at Grand Junction and public release of the data, it is not possible to test the normality of the last quarter. Instead, the months of October, November, and December of 1975 were tested, continuing the pattern of the preceding quarterly reports.

Comparisons of meteorological data at 700 mb, the first standard barometric level above the entire terrain at Grand Junction and the tracts, are presented on Table III-2. These comparisons show that the average wind speed in October was about 2 m/s to 2.5 m/s (4.5 mph to 5.6 mph) higher than the 10-year norm. Also, the average temperature in December was about 2°C (3.6°F) warmer than the corresponding 10-year average. Except for these short-term deviations, meteorological conditions from October through December at Grand Junction can be considered relatively normal, and by inference the conditions on the tracts during this period should have been relatively representative of their averages for these months.

2. DIFFUSIVITY

The dispersion or dilution of windborne effluents in the atmospheric boundary layer greatly depends on the turbulence intensity, or the diffusivity, of the atmosphere. Diffusivity on the tracts can be characterized by a number of routine meteorological measurements.

One approach to characterizing diffusivity is to compare temperatures at two surface stations in close proximity to each other but at different elevations. It was pointed out in the fourth quarterly report that qualitatively the Station A-6 and Station A-2 temperature comparison shows the proper trends over the 1,610 m to 1,628 m (5,280 ft to 5,340 ft) altitude range and that the Station A-6 and Station A-2 temperature comparison shows the proper trends over the 1,610 m to 1,754 m (5,280 ft to 5,755 ft) range. Figure III-7 shows

TABLE III-2

UPPER AIR DATA

Comparison of 700 mb monthly average upper air data at Grand Junction, Colorado, from October 1975 through December 1975 with their corresponding 10-year means. The 10-year norm and the deviation of current data from this norm are tabulated.

	Morning (0500 MST) Soundings						Afternoon (1700 MST) Soundings					
	Wind Speed (m/s)		Temp		Rel. Hum. (%)		Wind Speed (m/s)		Temp		Rel. Hum. (%)	
Month	Norm	Dev	Norm	Dev	Norm	Dev	Norm	Dev	Norm	Dev	Norm	Dev
Oct	3.4	2.0	2.3	0.1	50	-11	3.6	2.5	4.0	0.6	42	-9
Nov	5.1	0.2	-3.4	-0.7	57	-9	5.0	-0.3	-2.4	-0.3	51	-7
Dec	5.7	-1.3	-7.0	2.3	62	-6	5.6	-1.8	-6.2	1.9	54	1

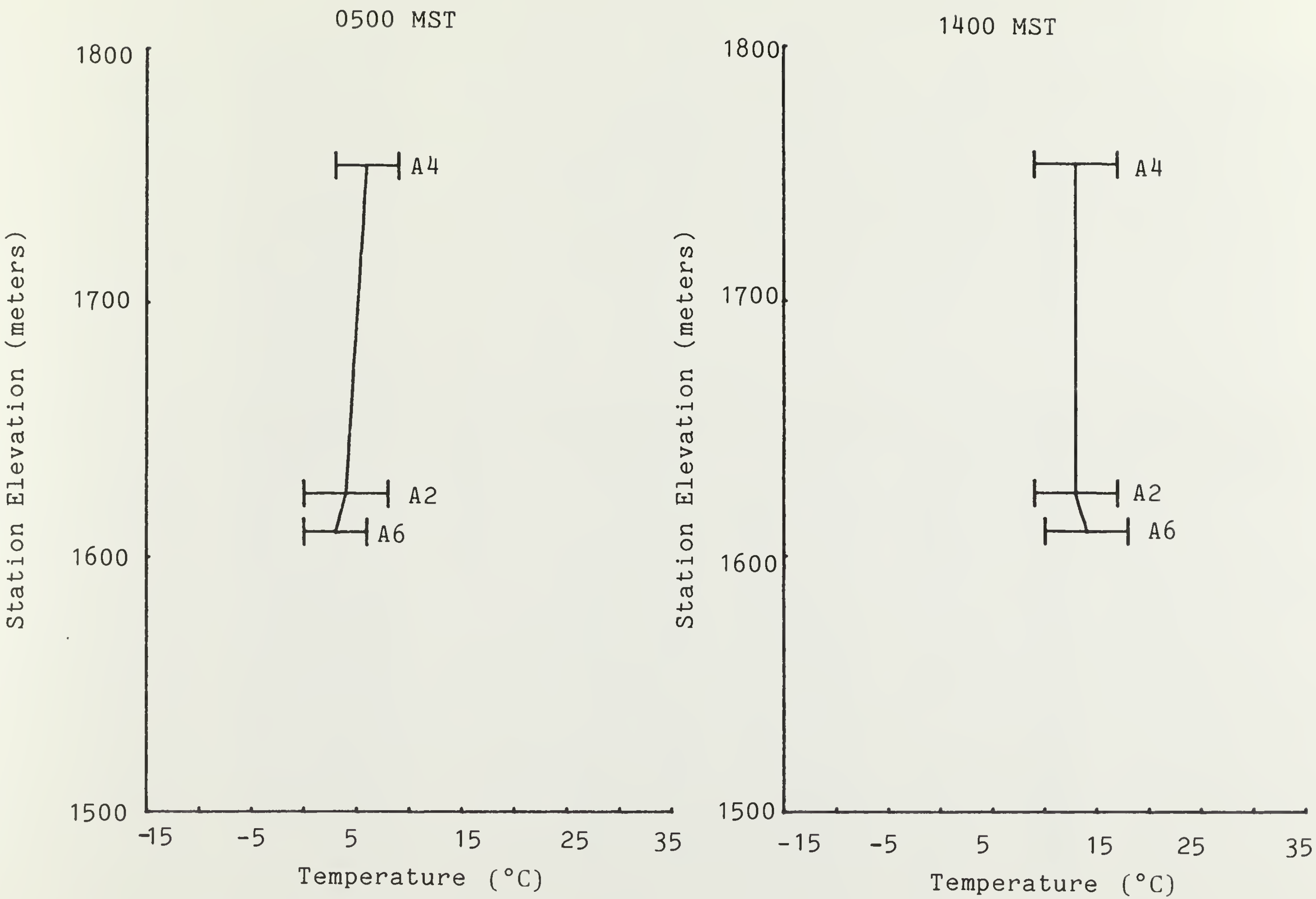


FIGURE III-7. AVERAGE APRIL TEMPERATURE (0500 AND 1400 MST) AND STANDARD DEVIATIONS AS A FUNCTION OF STATION ELEVATION. Multiply meters by 3.28 to get feet.

the average temperatures and their standard deviations at stations A-2, A-4, and A-6 at 0500 and 1400 MST in April. The data are plotted against the height of the station to give a "sounding" of temperature. The average temperature at Station A-4 was comparable to that at Station A-2, and temperatures at both stations were higher than the temperature at Station A-6 in the morning and lower than the temperature at Station A-6 in the afternoon. This indicates the existence of surface-based inversions in the morning and near-neutral conditions in the afternoon above Station A-6.

The dispersion of a plume is often described mathematically by the diffusion equation having the following form,

$$\frac{\chi}{Q} = \frac{1}{\pi\sigma_y\sigma_z U} \exp\left[-\frac{1}{2}\left(\frac{H}{\sigma_z}\right)^2\right]$$

where χ is the surface concentration, Q is the source emission rate, σ_y, σ_z are the horizontal and vertical dispersion coefficients, respectively; U is the mean wind speed; and H is the effective stack height. MacCready et al. (1974) show that at downwind distances in excess of the order of a kilometer, $\sigma_y^2 \sim \sigma_v t$ and $\sigma_z^2 \sim \sigma_w t$ where σ_v and σ_w are the root-mean-square turbulence fluctuations in the lateral wind speed v and the vertical wind speed w and t is the time of plume travel. Using these relationships for H = 0, and noting that the location of a receptor is given by x = Ut, the equation is as follows:

$$\frac{\chi}{Q} \sim \frac{1}{(\sigma_v\sigma_w)^{1/2}x}.$$

This relationship, with H taken as zero, is valid along the centerline of a plume released aloft or at the surface for emissions released also at the surface (although ground effect makes the constant of proportionality twice as great in the latter case as in the former). For other cases the decay in χ/Q with x is even greater because of the growth of σ_z in the exponential term of the full equation.

This type of analysis is appropriate for estimation of the surface impact of surface releases and also for the impact of elevated releases on isolated points of elevated terrain (where roughly the centerline concentration applies). For

receptors off the plume centerline, the exponential term, which includes concentration decay with wind speed as

$$\exp\left(-\frac{k\ H^2 U}{\sigma_W x}\right)$$

must be included in the analysis. Its impact will always be that of decreasing the concentrations expected.

Using this approach, a quantitative characterization of diffusivity on the tracts is possible using the measurements of σ_V ($\sigma\theta = \sigma_V/U$) and of σ_W made continuously at stations A-2 A-4, and A-6. Table III-3 presents the frequency distributions of the quantity $(\sigma_V\ \sigma_W)^{1/2}$, which is inversely proportional to χ/Q at any given receptor location for the month of April at Station A-2. (As pointed out earlier, wind data at Station A-6 was not yet calibrated at the time of report preparation, so that data could not be used.) The data shown in the table indicates that diffusion conditions, in terms of $\sqrt{\sigma_V \sigma_W}$ typically ranged from 0.2 m/s to 0.8 m/s (0.7 ft/s to 2.6 ft/s). Low values were generally observed at night and high values in the afternoon, as has generally been the case during the baseline program.

This approach to diffusion estimation does not require inference of low altitude diffusion from termperature lapse rate data, a dubious process in the very rugged terrain of the area, but rather presents quantitative measurements of actual diffusion. Using generally accepted boundary layer formulas and measured lapse rate data from the rawinsonde, these values can often be extrapolated upward to allow estimation of conditions at levels above the 30-m (100-ft) tower tops.

REFERENCES

MacCready, P.B., Jr., L. Baboolal, and P.B.S. Lissaman. 1974. Diffusion and turbulence aloft over complex terrain. Symposium on Atmospheric Diffusion and Air Pollution, American Meteorological Society, Santa Barbara, California. AeroVironment Inc. Technical Paper 432.

TABLE III-3

DIFFUSIVITY

Relative frequency distribution (%) of $\sqrt{\sigma_V \sigma_W}$ (m/s) at Station A-2 in April 1976. All measurements were made 30 m above the surface. All hours of the day are included.

$\sqrt{\sigma_V \sigma_W}$ Range*	0.00	0.20	0.40	0.60	0.80	1.00	1.20	>1.20	Total # of Obs.
% Frequency	0	25	19	21	17	11	6	1	720

* Each interval of $\sqrt{\sigma_V \sigma_W}$ spans 0.2 m/s and commences with the value shown.

σ_V is the root-mean-square turbulence fluctuations in the lateral wind speed (v).

σ_W is the root-mean-square turbulence fluctuations in the vertical wind speed (w).

3. AIR QUALITY

a. Gaseous Pollutants

Sulfur dioxide and H_2S are monitored at eight sites on the tracts. In addition, CO, HC, NO_2, and O_3 are monitored at three of the eight sites. There are no state air quality standards for gaseous pollutants, and federal standards exist for all components except H_2S. For reference in the ensuing discussion, Table III-4 presents the Federal Ambient Air Quality Standards (AAQS) for the various gaseous pollutants monitored on the tracts. For H_2S, a reference for interpreting the data is the California 1-hour standard of 42 $\mu g/m^3$ (0.03 ppm).

The air quality has consistently been good on the tracts, as expected because of their remote location. During this quarter, except for sporadic occurrences of high non-methane hydrocarbon (NMHC) readings, the air on the tracts was relatively clean with respect to gaseous pollutants. The only other pollutant present in measurable quantities was ozone, which has a natural non-zero background level. Otherwise, almost all instruments measuring gaseous pollutants were recording at their threshold limit most of the time.

A plot of diurnal variations of ozone at Station A-2 in April is shown on Figure III-8. The average diurnal trend consisted of low readings of about 50 $\mu g/m^3$ (0.03 ppm) between 0300-0700 MST in the early morning hours and higher values of 90 $\mu g/m^3$ (0.04 ppm) between 1400-1700 MST in the afternoon. No cases of air quality exceeding the standard were observed. Very little diurnal variation was observed for all other pollutants. Station-to-station variability of gaseous pollutants has consistently been small.

Table III-5 shows the peak and second highest values as well as the percentage of observations exceeding standards for all gaseous pollutants observed on the entire tract area in the quarter. The values are given for the time averages for which air quality standards exist. The data are representative of the worst air quality situation on the tracts during this season.

Even so, these values are low compared with the standards. All of them, except ozone and NMHC values, are near the detection thresholds of the instruments. As a matter of fact, H_2S and SO_2 variations are simply due to variability in instrument responses near their thresholds. Thus, the relatively high quality of air on the tracts is illustrated.

TABLE III-4

FEDERAL AIR QUALITY STANDARDS FOR GASEOUS POLLUTANTS

Pollutant	Averaging Time	Primary Standards	Secondary Standards
Ozone (O_3)	1 hour	160 $\mu g/m^3$ (0.08 ppm)	same as primary
Carbon Monoxide (CO)	8 hours	10 mg/m^3 (9 ppm)	same as primary
	1 hour	40 mg/m^3 (35 ppm)	same as primary
Sulfur Dioxide (SO_2)	Annual Average	80 $\mu g/m^3$ (0.03 ppm)	-
	24 hour	365 $\mu g/m^3$ (0.14 ppm)	-
	3 hour	-	1300 $\mu g/m^3$ (0.5 ppm)
Nitrogen Dioxide (NO_2)	Annual Average	100 $\mu g/m^3$ (0.05 ppm)	same as primary
Hydrocarbons (corrected for methane) (NMHC)	3 hour (6-9 a.m.)	160 $\mu g/m^3$ (0.24 ppm)	same as primary

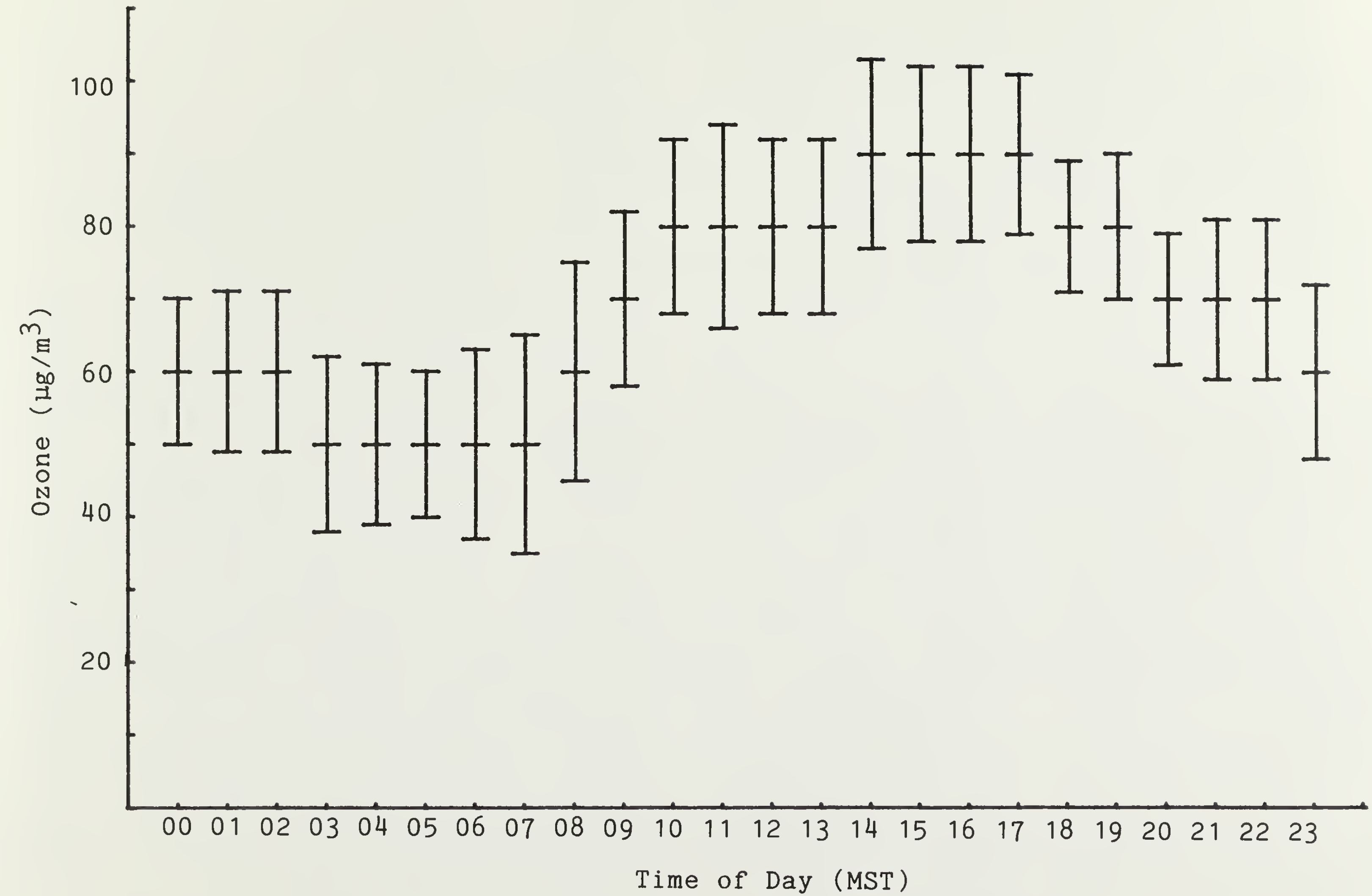


FIGURE III-8. OZONE CONCENTRATIONS. Diurnal variation in mean ozone concentrations with their standard deviations at Station A-2 during spring, based on data for the central month of the quarter (April).

TABLE III-5

PEAK GASEOUS POLLUTANTS CONCENTRATIONS

The peak and second highest values as well as the percent of observations exceeding standards for all gaseous pollutants observed on the tracts in April.

Pollutant	Averaging Time	Peak Conc.	Second Highest Conc.	Average	Standard	Percent Observations Exceeding Standard
O_3 ($\mu g/m^3$)	1 Hour	140	140	70	160	0
CO (mg/m^3)	8 Hours	0.7	0.6	0.2	10	0
	1 Hour	0.9	0.9	0.2	40	0
SO_2 ($\mu g/m^3$)	24 Hours	15	10	5	365	0
	3 Hours	15	15	5	1300	0
	1 Hour	20	20	5	--	--
H_2S ($\mu g/m^3$)	1 Hour	30	30	0	--	--
NO_2 ($\mu g/m^3$)	1 Hour	80	60	0	--	--
NMHC ($\mu g/m^3$)	3 Hour (6-9 A.M.)	160	150	48	160	0

b. Particulates and Trace Metals

Particulate concentrations on the tracts are monitored using high-volume samplers that sample over a period of 24 hours once every six days simultaneously at all eight air monitoring sites. The sizes of particulates collected by the samplers range from below 1 μm to somewhat above 25 μm.

Table III-6 shows the geometric mean, standard geometric deviation, and maximum, and minimum of particulate concentrations in $\mu g/m^3$ at all sites in the spring quarter. Data collected between March 1 and May 31 were used, except for stations suspended May 1.

Because particulate concentrations have been found to be lognormally distributed in general, the geometric mean presented can be considered to correspond to the concentration to be expected at a 50% frequency. The geometric mean of particulate concentrations ranged from 10.9 $\mu g/m^3$ at Station A-3 to 24.0 $\mu g/m^3$ at Station A-5. There was noticeable spatial variation on the tracts. Station A-5, at the base of a cliff on the west bank of the White River and about 1/8 mi west of the main direct road linking Bonanza and the tracts, was the dirtiest station with respect to particulates. Concentrations at all sites were generally high on days with high winds.

None of the recorded values exceeded federal or state standards, which are shown on Table III-7. The most stringent short-term standard is the National Secondary Standard, which sets the upper limits at 150 $\mu g/m^3$ averaged over 24 hours; this is not to be exceeded more than once a year.

Between January 23 and April 15, 1976, two sets of size fractionated particulate samples were collected at Station A-2 by means of a Multistage Lundgren impactor and were analyzed for trace elements using ion-excited x-ray emission techniques at 50 microcoulombs. Table III-8 shows the elements detected during these sampling periods. Most of the elements, with the exception of normal soil constituents, were found at concentrations of less than or around 10 ng/m^3, with most of the mass generally found in the smaller size fractions. The elements that existed in larger quantities were Na, Al, Si, S, K, Ca, and Fe. Concentrations of typical anthropogenic aerosols such as S, Cu, Zn and the automotive-derived aerosols of Br and Pb were very low, only a few percent of typical urban values.

From November 1975 through March 1976, trace-metal analysis was also performed on particulates collected by the high-

TABLE III-6

PARTICULATE CONCENTRATIONS

The geometric mean, standard geometric deviation and maximum and minimum of particulate concentrations ($\mu g/m^3$) at stations A-1 to A-8 in the spring quarter (March 1 through May 31).

Station	Geometric Mean	Standard Geometric Deviation	Maximum	Minimum
A1*	13.8	1.8	38.3	4.6
A2*	15.1	1.9	60.2	7.9
A3	10.9	1.9	39.5	4.5
A4	17.9	1.8	63.8	7.3
A5*	24.0	1.8	75.2	9.2
A6	17.2	1.9	45.1	4.9
A7	15.8	2.0	77.7	6.6
A8*	22.0	1.8	59.5	9.9

* Measurements suspended on 1 May 1976.

TABLE III-7

AMBIENT AIR QUALITY STANDARDS FOR PARTICULATE MATTER ($\mu g/m^3$)

Pollutant	Averaging Time	National Standard* Primary	National Standard* Secondary
Suspended Particulate Matter	Annual Geometric Mean	75	60
	24 Hour	260	150

*The Utah Ambient Particulate Standards were rescinded July 9, 1975 and the National Standards apply statewide.

volume sampler at Station A-2. Since x-ray emission techniques could not be used on these filters, atomic absorption was used to identify Li, Na, K, and Hg; turbidimetric wet analysis to detect S; titrimetric wet analysis for Cl and Br; colorimetric analysis for As; and emission spectrography for all the other elements. Particulate sizes collected ranged from under 0.1 μm to above 25 μm. Thus, much larger particles than those collected by the multiday impactor were present. This, together with the fact that different techniques other than x-ray emissions were used, gave the results shown on Table III-9, which are somewhat different from those on Table III-8.

As shown on Table III-9 (the same format as Table III-8), the elements Na, Al, Ca, Ti, V and Cr were detected in concentrations of greater than 500 ng/m^3. The sizes of the particles containing these elements are probably greater than the 20 μm cutoff of the Lundgren impactor, since their concentrations were usually much lower than 500 ng/m^3 when x-ray emission techniques were used. Analysis for silicon could not be performed because Si is a major constituent of the glass fiber filters on which the samples were collected. All of the analyses were corrected for trace amounts of other filter elements.

c. Visibility

The clarity of the atmosphere on the tracts is monitored by three methods: (1) continuous recording of light-scattering coefficient with an integrating nephelometer at Station A-2; (2) photographic recording of visibility on color and monochromatic film from an observation point above Station A-9; and (3) visual observations at the same time as the photographic records are made.

The integrating nephelometer recorded an average scattering coefficient of $0.04 \times 10^{-3}m^{-1}$ during this quarter, which corresponds to a local visual range (assuming a 2% contrast threshold for the eye) of 118 km (73 mi). The highest scattering recorded was $b_s = 0.22 \times 10^{-3}m^{-1}$, which corresponds to a local visual range of 21 km (13 mi), observed at 0000 MST on April 2. This is the lowest local visual range ever observed on the tracts. This incident followed a period of high winds. The most clear hours had $b_s = 0.02 \times 10^{-3}m^{-1}$ (visual range 235 km, or 146 mi), which was also previously observed in the winter with snow cover on the ground. This latter value is of clarity comparable to that of particle-free air. All observed values have corresponded to extremely clear, background-quality air.

TABLE III-8

TRACE ELEMENTS DETECTED AT STATION A-2 USING ION-EXCITED X-RAY EMISSIONS TECHNIQUE. Any elements not shown have not been detected.

Sampling Record	Sensitivity of Analysis	Size (μm) Range	Na	Mg	Al	Si	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	As	Se	Br	Rb	Sr	Zr	Ba	Pt	Au	Hg	Pb	Co
1/23-2/25	50 μC	3.6-20.0	A	A	B	C	A	C	B	B	A	*	*	A	B	A	A	A	-	-	*	-	-	-	A	-	A	A	A	-
		0.65-3.6	B	*	B	B	B	A	A	A	*	*	*	A	A	A	A	A	-	-	A	A	A	-	A	-	A	A	A	-
		0.10-0.65	D	B	C	D	E	*	B	B	A	A	A	A	B	*	A	A	-	-	A	-	-	-	B	-	-	-	B	A
3/8-4/15	50 μC	3.6-20.0	D	C	C	D	B	C	B	D	A	*	A	A	C	*	A	*	-	A	A	A	A	-	*	A	-	A	A	-
		0.65-3.6	B	C	C	D	C	C	C	D	A	*	*	A	C	*	A	A	A	-	*	-	B	-	*	-	-	A	A	-
		0.10-0.65	C	D	D	E	E	*	C	D	A	A	A	A	D	A	A	A	-	A	A	A	-	-	*	B	A	-	B	-

-   Element not found
*   Concentration <detection limit

A   10 $ng/m^3 >$ concentration > 0 ng/m^3

B   50 $ng/m^3 >$ concentration ≥ 10 ng/m^3

C   100 $ng/m^3 >$ concentration ≥ 50 ng/m^3

D   500 $ng/m^3 >$ concentration ≥ 100 ng/m^3

E   concentration ≥ 500 ng/m^3

TABLE III-9

TRACE ELEMENTS ON HIGH VOLUME SAMPLER FILTERS COLLECTED AT STATION A-2 FROM NOVEMBER 8, 1975 TO MARCH 13, 1976

Sampling Date	Li	Be	Na	Mg	Al	Si	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	As	Se	Br	Rb	Sr	Zr	Ba	Pt	Au	Hg	Pb
11/8/75	A	C	E	E	E	NA	*	D	D	E	E	E	E	C	E	D	B	D	C	*	*	D	D	D	D	NA	B	*	C
12/14/75	*	A	E	D	E	NA	A	D	D	E	E	E	D	A	D	B	B	B	B	*	*	C	C	C	C	NA	A	*	B
1/31/76	*	A	E	C	E	NA	A	D	D	E	E	E	D	B	E	C	D	C	B	B	*	B	C	C	D	NA	*	*	A
2/18/76	*	A	E	B	E	NA	*	D	D	E	E	E	D	B	E	C	D	C	C	*	*	C	B	C	D	NA	A	*	A
3/13/76	A	A	E	B	D	NA	A	D	C	E	E	E	D	A	D	B	B	B	B	*	*	B	B	B	C	NA	A	*	A

- * Concentration < detection limit
- A $10\ ng/m^3 >$ concentration $\geq 0\ ng/m^3$
- B $50\ ng/m^3 >$ concentration $\geq 10\ ng/m^3$
- C $100\ ng/m^3 >$ concentration $\geq 50\ ng/m^3$
- D $500\ ng/m^3 >$ concentration $\geq 100\ ng/m^3$
- E $> 500\ ng/m^3$
- NA Not analyzed

A diurnal variation in scattering coefficient continues to be observed, with the night and early morning hours generally showing about 15% more scattering (lower visibility) than the afternoon and evening hours. This diurnal effect shows that fine-scale particulates (of natural or anthropogenic origin) collect near the ground during the stable, calm night hours and are mixed into the atmosphere during the better ventilated hours, and that the increased human activity and winds on the tracts during the day do not stir up enough dust to counteract this stability. This variation was not present in the summer, but was observed last winter and spring.

Photographic visibility measurements were made on March 5, April 1, and May 1. None of these days demonstrated any significant obstructions to visibility. The photographically-derived visibilities and those computed from the integrating nephelometer measurements correlate well, indicating as before that the Uintah Basin air mass is relatively homogeneous and that the localized nephelometer measurements are representative of a large area.

4. RADIATION

Continuous monitoring of ambient radiation throughout the tracts by thermo-luminescent dosimeters at all 12 stations shows radiation throughout the study area to be in the normal ambient range. The average radioactivity levels measured by thermo-luminescent dosimetry at all 12 stations between January 23 to April 22 are tabulated on Table III-10. The readings ranged from 7 mR at Station A-8 to 13 mR at Station A-2. These values are consistent with data from the previous quarters.

C. WORK SCHEDULED

Routine continuous monitoring and data processing of all air resources parameters, except those that were suspended in May, as discussed in Section III.A., will continue throughout the next quarter.

TABLE III-10

RADIATION LEVELS

Average radiation levels at all stations during January 23 to April 22, as measured by three thermo-luminescent dosimeters at each station.

A-1 - 9 mR	A-7 - 11 mR
A-2 - 13 mR	A-8 - 7 mR
A-3 - 10 mR	A-9 - 11 mR
A-4 - 10 mR	A-10 - 10 mR
A-5 - 7 mR	A-11 - 11 mR
A-6 - 9 mR	A-12 - 9 mR

IV. BIOLOGICAL RESOURCES

A. <u>WORK COMPLETED</u>

1. VEGETATION

Phenology plots were analyzed during the quarter. Plant development, soil temperature, and soil-surface temperatures were recorded, and phenological codes for 22 possible stages of development or occurrence were applied as appropriate.

2. TERRESTRIAL VERTEBRATES

a. <u>General</u>

The April sampling period was completed, with bird and mammal transects conducted as scheduled. Reptile transects were not conducted because of cold, wet weather. Large rodent-trap grids and some transect traps were set up, but inclement weather prevented completion of trapping.

b. <u>Mule Deer</u>

The deer-monitoring program initiated in 1975 was continued during the quarter. Four deer were successfully monitored during March and April, and in May, three deer were located.

c. <u>Mourning Doves</u>

During late May and early June, standardized routes were used to count mourning dove coo-calls. One route, which has been used yearly since 1964 by DWR personnel, begins at the southern end of Deadman Bench on Utah Highway 45, runs south through Bonanza, and ends close to Evacuation Creek in Dragon Canyon. The state route skirts one perimeter of the tracts. The second route begins in Wagonhound Canyon and runs generally east to west through the tracts, ending near the mouth of Asphalt Wash.

d. <u>Canada Geese</u>

Four float trips were completed on the White River from stations S-1 to S-11 to census Canada geese and other waterfowl.

e. <u>Raptors</u>

The spring raptor survey was completed in late May. Two days were spent in an on-the-ground survey of all areas of the tracts to observe raptor activities, and one day was spent floating the White River to observe raptor activities along the river. Records were kept of raptors observed, their nesting activities and locations, and young produced when they could be seen.

f. <u>Browse Transects</u>

A series of Cole extensive browse-use transects were completed in April and May. A total of 32 transects, 8 in each vegetation type, were read. The species studied were sagebrush (*Artemisia*) and greasewood (*Sarcobatus*) because they are found in various areas of each vegetation type on the tracts. Sagebrush is a staple forage species for deer and livestock, and greasewood is a staple winter food for sheep. This information will indicate the levels of use by livestock and deer in the various areas of the tracts. It is hoped that spring and fall transect readings will permit differentiation of livestock and deer use.

3. TERRESTRIAL INVERTEBRATES

During the quarter several groups of Coleoptera (beetles), Hymenoptera (wasps), and Diptera (flies) were sent to specialists for determination. Several groups sent previously (Hymenoptera and Diptera) were returned with varying degrees of specificity in the determinations, because of the difficulties involved in identifying certain groups. For example, several families of gnats (Chloropidae, etc.) were sent to Dr. Curtis Sabrosky, the world's principal authority on these families. Among the 74 species represented, he listed 23 as undescribed (species new to science) and 8 as unidentified and possibly new (see Data Summary). Such a finding will probably be typical of many of the poorly known families in the survey.

4. AQUATIC BIOLOGY

On-site aquatic biology studies were conducted from March 15 to March 23, 1976. The sampling period began approximately one week after the spring ice break-up, and water temperatures remained near 0°C during sampling. The channel was clear, but ice ledges extended 2 m or 3 m into the water from each shoreline. Water levels fluctuated daily, and discharge increased considerably in the afternoons as the days became warmer. Transparency decreased steadily through the day as water levels increased, and the load of floating ice increased from small scattered chunks in the morning to blocks more than 10 m long by late afternoon.

Aquatic flora and fauna can experience considerable impact from ice break-up, as illustrated by an incident at Station F-3. The bottom structure of the stream section between the Bonanza bridge and the first downstream bend is normally composed of stones ranging in size from gravel to small boulders and is quite productive of invertebrates, with usually a high standing crop of periphyton. During the ice break-up an ice jam at the bend below the bridge drastically altered these conditions by creating a dam across the bend and causing a decrease in current velocity that allowed suspended sand particles to settle to the bottom. The entire section of streambed became blanketed with a layer of fine sand approximately 25 cm (10 in.) thick. The high discharge rates that occur with spring runoff may carry the sand away and return the streambed to near its original state, but in the interim, the area has become uninhabitable for most of the invertebrates that normally occur there. Invertebrates usually abandon such areas as they become covered and move to areas where the substrate is suitable for attachment.

5. MICROBIOLOGY

Microbiologists revisited all sites May 28, 1976, to observe vegetation characteristics. Based on these observations the vegetation descriptions submitted in the fourth quarterly report (September 1, 1975) were modified (see Data Summary). This report includes the last of the 1975 data, the results of analyses on all 1975 samples not previously submitted, and data from the current quarter.

B. DATA SUMMARY

1. VEGETATION

The data are being processed.

2. TERRESTRIAL VERTEBRATES

a. General

Species Inventory

Fifty-eight species of birds were observed on or within a 1.6-km (1-mi) boundary of the tracts (Table IV-1). Four species were seen for the first time: cinnamon teal, greater yellowlegs, Bewick's wren, and savannah sparrow. The insectiverous birds seen in April 1975, including some flycatchers and warblers, were not seen. So far, 121 bird species have been observed on the tracts.

Twenty-one species of mammals were observed or trapped on or within a 1.6-km (1-mi) boundary of the tracts (Table IV-2). Three species are questionable: mountain cottontail, golden-mantled ground squirrel, and Colorado chipmunk. Notable absences from the list are the carnivores and scavengers.

Two species of mice have been mis-identified in the Juniper vegetation type. Present in this habitat are the canyon mouse (*Peromyscus crinitus*) and the pinyon mouse (*P. truei*). The mistake in past quarterly reports has been constant and will not effect the data previously collected. To correct these reports, change the listing of pinyon mouse to canyon mouse, and change brush mouse (*P. boylei*) to pinyon mouse.

Five species of reptiles were observed on or within a 1.6-km (1-mi) boundary of the tracts: sagebrush lizard, side-blotched lizard, tree lizard, gopher snake, and yellow-bellied racer. Reptile activity increased in the last two days of sampling.

Species Distribution

Nine bird species were found in all habitats: golden eagle, red-tailed hawk, kestrel, Say's phoebe, magpie, rock wren,

TABLE IV-1

AVIAN SPECIES LIST FROM OBSERVATIONS ON OR WITHIN 1.6 KM (1 MILE) OF UTAH OIL SHALE TRACTS, APRIL 1976

G = greasewood, J = juniper, S = shadscale, R = riparian

Bird (Order/Species)	Date/Vegetation Type April 1976				Date of Arrival 1975		1976	
	G	J	S	R	Month	Day	Month	Day
Anseriformes								
Mallard	-	-	-	X				
Gadwall	-	-	-	X				
Northern Shoveler	-	-	-	X				
Green-winged Teal	-	-	-	X				
Cinnamon Teal	-	-	-	X				
Canada Goose	-	-	-	X				
Falconiformes								
Turkey Vulture	-	-	X	X	4	13	4	8
Marsh Hawk	-	-	X	-	R		R	
Cooper's Hawk	X	-	-	-	R?		R?	
Sharp-shinned Hawk	-	-	X	X			R?	
Red-tailed Hawk	X	X	X	X			*	
Golden Eagle	X	X	X	X	R		R	
American Kestrel	X	X	X	X	*		*	
Gruiformes								
Sandhill Crane	-	-	X	X	4	11	*	
Chadriiformes								
Killdeer	-	-	-	X	4	16	4	8
Greater Yellowlegs	-	-	-	X			4	23
Columbiformes								
Mourning Dove	X	-	X	X	4	8	4	12

TABLE IV-1 (Cont.)

Bird (Order/Species)	Date/Vegetation Type April 1976				Date of Arrival 1975		Date of Arrival 1976	
	G	J	S	R	Month	Day	Month	Day
Strigiformes								
Great Horned Owl	-	-	X	X	R		R	
Apodiformes								
Broad-tailed Hummingbird	-	-	-	X			4	23
White-throated Swift	-	-	-	X	4	10	4	8
Coraciiformes								
Belted Kingfisher	-	-	-	X			4	21
Piciformes								
Hairy Woodpecker	-	-	-	X	R?		R?	
Downy Woodpecker	-	-	-	X	R		R	
Common Flicker (Red-shafted)	-	X	-	X	R		R	
Passeriformes								
Say's Phoebe	X	X	X	X	4	5	*	
Horned Lark	-	-	X	-	R		R	
Violet-green Swallow	-	-	-	X			4	23
Black-billed Magpie	X	X	X	X	R		R	
Common Raven	X	X	X	-	R		R	
Pinyon Jay	X	X	-	-	R		R	
Plain Titmouse	-	X	-	-	R		R	
Black-capped Chickadee	-	-	-	X	R		R	
Common Bushtit	-	X	-	-				
Rock Wren	X	X	X	X	4	16	*	
House Wren	-	-	-	X			4	20
Bewick's Wren	X	X	-	X			4	6
Sage Thrasher	X	-	X	-	4	18	*	
Townsend's Solitaire	-	X	-	X				
American Robin	X	X	X	X	*		*	

TABLE IV-1 (Cont.)

Bird (Order/Species)	Date/Vegetation Type April 1976				Date of Arrival 1975		1976	
	G	J	S	R	Month	Day	Month	Day
Passeriformes (Cont.)								
Mountain Bluebird	X	X	X	X	*		*	
Blue-grey Gnatcatcher	-	-	-	X	4	25	4	20
Water Pipit	-	-	-	X	4	22	4	8
Loggerhead Shrike	X	-	X	-	R		R	
Starling	-	-	X	X			*	
Yellow-rumped Warbler (Audubon's)	-	-	-	X	4	22	4	19
Western Meadowlark	X	-	X	X			*	
Brewer's Blackbird	-	-	X	-			2	18
House Finch	X	X	X	X	4	15	*	
Savannah Sparrow	-	-	X	X			4	22
Vesper Sparrow	X	-	X	-	4	17	4	6
Lark Sparrow	-	-	X	X	4	23	4	22
White-crowned Sparrow	X	-	-	X			4	7
Chipping Sparrow	X	X	-	-	4	23	4	16
Brewer's Sparrow	X	-	-	X	4	23	4	18
Dark-eyed Junco (Oregon)	X	X	-	X	R		R	
Black-throated Sparrow	X	X	X	-	4	16	4	14
Sage Sparrow	X	-	X	-	*		2	14
Rufous-sided Towhee	X	X	-	X	4	8	*	

* - After 2-18-76, Prior to 4-4-76
R - Resident Year-Round
? - Questionable Observation
X - Bird Observed

TABLE IV-2

MAMMALIAN SPECIES LIST FROM OBSERVATIONS ON OR WITHIN 1.6 km (1 MILE) OF UTAH OIL SHALE TRACTS, APRIL 1976

X = mammal observed, G = greasewood, J = juniper, S = shadscale, R = riparian

Mammal (Order/Species)	Date/Vegetation Type April 1976			
	G	J	S	R
Rodentia				
Yellow-bellied Marmot	X	-	-	-
White-tailed Antelope Squirrel	X	X	X	-
Golden Mantle Squirrel	-	-	-	?
Least Chipmunk	X	X	-	-
Colorado Chipmunk	?	-	-	-
White-tailed Prairie Dog	-	-	X	-
Apache Pocket Mouse	X	X	X	-
Ord's Kangaroo Rat	X	-	X	X
Western Harvest Mouse	X	-	-	-
Deer Mouse	X	X	X	X
Brush Mouse	-	X	-	-
Pinyon Mouse	-	X	-	-
Desert Woodrat	X	X	-	-
Bushy-tailed Woodrat	-	X	-	-
Beaver	-	-	-	X
Muskrat	-	-	-	X
Porcupine	-	-	-	X
Lagomorpha				
Desert Cottontail	X	X	X	X
Mountain Cottontail	-	?	-	-
Artiodactyla				
Mule Deer	X	X	X	X
Domestic Sheep	X	X	X	X

? - Questionable Observation

robin, mountain bluebird, and house finch. Twenty species were found only in the riparian habitat (Table IV-1). Marsh hawks, horned larks, and Brewer's blackbirds were found only in the shadscale habitat, and the plain titmouse and common bushtit, only in juniper habitat. Sandhill cranes were seen and heard flying over the tracts and were once observed landing on the tracts (October 1975). Forty-three species were seen in the riparian habitat, 26 in the shadscale, 25 in the greasewood, and 19 in the juniper.

Of the 18 mammal species positively identified, 11 were seen in the greasewood and juniper and 8 in the riparian and shadscale (Table IV-2). Deer mice, desert cottontails, mule deer, and domestic sheep were found in all habitats. Beavers, muskrats, and porcupines were seen only in the river bottom. Pinyon mice, canyon mice, and bushy-tailed woodrats were seen only in the juniper habitat, and yellow-bellied marmots and western harvest mice were seen only in the greasewood habitat. Approximately 2000 sheep were held for 10 days in the area extending from the eastern boundary of Southam Canyon to Hell's Hole Canyon while awaiting shearing.

Species Density

Ther term "animal density" refers to the abundance, or concentration, of animals in an area. Population densities are studied by various trapping and observational procedures in which a series of numerical data is collected, compiled, and reported as a density estimate. Densities are expressed as number observed and as number per hectare (ha).

In tables IV-3 and IB-4, some qualification to the density estimates have been added. The column heading "Number of Samples" has been changed to read "Number of Observed Samples." This allows the reader to weigh the number of animals against their frequency of observation. A 5 is recorded when an animal is observed each time a transect is walked. A new heading, "Number of Auditory Samples," designates how often a species was heard in five possible samples. A second new heading, "Status" refers to residence in an area "R," passage through an area "P," and questionable "?."

Data collected and reported in previous quarterlys do not change and will be correlated into the final report using this new methodology.

The formula for calculating density in number/hectare is as follows:

TABLE IV-3

BIRD NUMBERS, DENSITY AND STATUS ETC., AND
STATUS ON SAMPLING SITES
DURING APRIL 1976, SAMPLING PERIOD

Sampling Site	Bird (Species)	No. Observed Samples	Density Observed	Density Per ha	Status	No. Auditory Samples
PG	Mourning Dove	1	1		P	
	Common Flicker					1
	Say's Phoebe					1
	Black-billed Magpie	1	2		P	2
	Pinyon Jay	1	3		P	3
	Plain Titmouse	2	3		R	1
	Rock Wren					1
	Sage Thrasher					1
	Mountain Bluebird	1	2		P	
	Dark-eyed Junco	1	4		P	
	Fringillidae, unidentified	1	6			
	Total	5	21	2.0		
SG	American Kestrel	1	1		P	
	Pinyon Jay	2	29		P	4
	Rock Wren	3	6	.3	R	4
	Black-throated Sparrow	2	3		R	
	Sage Sparrow	4	5	.6	R	
	Total	5	44	3.7		
OG	American Kestrel	2	4		R	
	Say's Phoebe					2
	Rock Wren	2	2		R	5
	Loggerhead Shrike	5	8	.4	R	
	Western Meadowlark	3	4	1.2	R	3
	Vesper Sparrow	1	2		?	
	White-crowned Sparrow	1	4		?	
	Chippira Sparrow	1	1		?	
	Black-throated Sparrow	2	5		R	
	Fringillidae, unidentified	3	4			
	Total	5	34	5.2		

PG - primary greasewood

SG - secondary greasewood
OG - off-tract greasewood

TABLE IV-3 (Cont.)

Sampling Site	Bird (Species)	No. Observed Samples	Density Observed	Density Per ha	Status	No. Auditory Samples
PJ	Common Flicker	1	1		R	
	Pinon Jay	5	80	5.4	R	5
	Plain Titmouse	2	3		R	2
	Common Bushtit	1	1		?	
	Rock Wren					1
	Mountain Bluebird	1	4		?	
	Dark-eyed Junco	2	4		R	
	Total	5	93	6.6		
SJ	Say's Phoebe	1	1		P	
	Common Raven	2	3		P	
	Pinon Jay	3	4		P	1
	Plain Titmouse	2	4		R	
	Rock Wren	2	2		R	5
	Bewick's Wren	1	1		?	
	Townsand's Solitaire	2	2		P	
	American Robin	1	1		P	
	Mountain Bluebird	5	11	1.6	R	
	House Finch	4	23	3.2	R	2
	Chipping Sparrow	4	13	4.0	R	
	Black-throated Sparrow	4	6	.8	R	
	Fingillidae, unidentified	1	1			
	Total	5	72	11.6		
OJ	American Kestrel	1	2		P	
	Common Flicker					1
	Black-billed Magpie	1	2	P	1	
	Pinon Jay	1	8		P	4
	Rock Wren					2
	Bewick's Wren	1	1		?	
	American Robin	1	2		?	
	Total	3	15	1.6		

PJ - primary juniper
SJ - secondary juniper
OJ - off-tract juniper

TABLE IV-3 (Cont.)

Sampling Site	Bird (Species)	No. Observed Samples	Density Observed	Density Per ha	Status	No. Auditory Samples
PS	Canada Goose					1
	Sandhill Crane					1
	American Kestrel	1	1		P	
	Horned Lark	1	1		R	1
	Rock Wren	1	1		R	2
	Sage Thrasher	1	1		R	2
	Western Meadowlark	1	1		R	5
	Vesper Sparrow	1	2		?	
	Sage Sparrow	5	12	.4	R	1
	Frigillidae, unidentified					2
	Total	5	19	1.0		
SS	Rock Wren	1	2		P	
	Sage Thrasher	2	5		R	1
	Western Meadowlark	4	12	1.2	R	5
	Sage Sparrow	2	9		R	
	Passerformes, unidentified	1	1			
	Total	5	29	5.6		
OS	Say's Phoebe	1	1		P	
	Black-billed Magpie					1
	Common Raven					1
	Rock Wren	1	1		R	
	Sage Thrasher	1	1		R	1
	Loggerhead Shrike	1	1		?	
	Western Meadowlark	3	6	.3	R	3
	Sage Sparrow	4	31	13.6	R	1
	Total	5	49	13.6		

PS - primary shadscale
SS - secondary shadscale
OS off-tract shadscale

TABLE IV-3 (Cont.)

Sampling Site	Bird (Species)	No. Observed Samples	Observed	per ha	Status	No. Auditory Samples
PR	Mallard	1	2		?	
	Cinnamon Teal	1	2		?	
	Canada Goose	2	5		R	
	Belted Kingfisher	1	1		?	
	Hairy Woodpecker	1	1		?	
	Downy Woodpecker	1	1		R	
	Common Flicker	3	5	.4	R	2
	Black-billed Magpie	2	5		R	
	Black-capped Chickadee	2	3		R	1
	Rock Wren					3
	American Robin	1	2		R	
	Mountain Bluebird					1
	Blue-gray Gratcatcher	1	1		?	
	Starling	4	7	1.2	R	
	House Finch					2
	Rufous-sided Towhee	2	2		R	1
	Strigidae, unidentified	1	1		R	
	Passeriformes, unidentified	1	1			
	Total	5	30	6.0		
OR	Canada Goose	3	8	.6	R	
	Teal, unidentified	1	2			
	Turkey Vulture	3	7	.6	R	
	Red-tailed Hawk	1	1		R	
	American Kestrel	1	2		?	
	Greater Yellowlegs	1	1		?	
	Mourning Dove	1	2		R	
	Broad-tailed Hummingbird	1	1		R	
	Belted Kingfloher	1	1		?	
	Dowry Woodpecker	1	1		R	
	Common Flicker					2
	Say's Phoebe	3	4	.6	R	
	Violet-green Swallow	1	1		?	
	Black-billed Magpie					1
	Black-capped Chickadee	1	1		R	1

PR - primary riparian
OR - off-tract riparian

TABLE IV-3 (Cont.)

Sampling Site	Bird (Species)	No. Observed Samples	Observed	per ha	Status	No. Auditory Samples
OR (Cont.)	Rock Wren					1
	Townsend's Solitaire	1	2		?	
	American Robin	5	12	2.4	R	
	Mountain Bluebird	2	2		R	2
	Starling	1	1		R	
	Yellow-rumped Warbler	1	3		R	
	Western Meadowlark	1	1		R	2
	House Finch	5	37	8.0	R	
	Rufous-sided Towhee	4	5	.4	R	
	Fringillidae, unidentified	1	2			
	Total	5	97	14.0		
RG	American Kestrel	4	5	.8	R	
	Killdeer	1	1		?	
	Common Flicker	2	2		R	4
	Black-billed Magpie	1	1		?	1
	Bewick's Wren	1	1		?	
	American Robin	2	9		?	
	Rufous-sided Towhee	4	7	2.4	R	3
	White-crowned Sparrow	1	2		?	
	Dark-eyed Junco	5	30	8.3	R	2
	Sage Sparrow	1	4		?	
	Passeriformes, unidentified	3	4			
	Total	5	66	18.4		

OR - Off-tract riparian
RG - riparian greasewood

1) R - resident
P - passage
? - questionable

TABLE IV-4

MAMMAL NUMBERS AND DISTANCE TRANSECT LINE
OR SAMPLING DURING APRIL 1976, SAMPLING

Sampling Site	Mammal (Species)	Density Number: No. Observed Samples	Observed	Per ha	Status	No. Auditory Samples
PG	Chipmunk (Least?)	1	2		R	
	Desert Cottontail	1	1		R	
SG	Desert Cottontail	2	2		R	
OG	Yellow-bellied Marmot	1	1		R	
	Desert Cottontail	5	15	1.2	R	
PG	Squirrel (White-tailed Antelope)	1	1		R	
	Bushy-tailed Woodrat	1	1		R	
	Desert Cottontail	3	4	.6	R	
SJ	Desert Cottontail	2	2		R	
OJ	Desert Cottontail	2	2		R	
PS	White-tailed Antelope Squirrel	1	1		R	
	Desert Cottontail	5	8	.6	R	
SS	Desert Cottontail	1	1		R	
OS	Domestic Sheep	3	1200		P	
PR	Mule Deer	1	5		R	
OR	Porcupine	3	3		R	
	Desert Cottontail	5	8	.4	R	
RG	Desert Cottontail	3	5	.8	R	

PG = Primary Greasewood
SG = Secondary Greasewood
OG = Off-tract Greasewood
PJ = Primary Juniper
SJ = Secondary Juniper
OJ = Off-tract Juniper
PS = Primary Shadscale
SS = Secondary Shadscale
OS = Off-tract Shadscale
PR = Primary Riparian
OR = Off-tract Riparian
RG = Riparian Greasewood

R = Resident
P = Passage
? = Questionable Observation

$$D = \left(\frac{N_i}{Lw_i\, n_i}\right)\left(\frac{10{,}000m^2}{ha}\right)$$

D = density (number/hectare)
N_i = individuals observed in one of eleven class intervals
L = length of transect, meters
w_i = class interval where individual was observed.
If an individual is seen 0-5 meters off the transect w_i = 1; 6-10m = 2; 11-15m = 3; 100 = 11.
n_i = number of transects walked
$10{,}000m^2/ha$ = conversion factor to ha.

Applying the formula to the collected data (Table IV-3 and IV-4), individuals observed within the first class interval (0 m to 5 m) are the most reliable observations. Where individuals are observed in this interval and possible other intervals, only the 0 m to 5 m are used in the calculation.

A total of 578 birds were observed in the transects on or within a 1.6-km (1-mi) boundary of the tracts (Table IV-3). Of this number, 202 birds were observed in the riparian habitat, 180 in the juniper habitat, 99 in the greasewood habitat, and 97 in the shadscale habitat. The most abundant species along the White River were house finches, robins, and geese. Dark-eyed juncoes were the most abundant in the riparian-greasewood, and sage sparrows and meadowlarks in the shadscale, jays and finches in the juniper, and shrikes, rock wrens and black-throated sparrows in the greasewood.

A total of 1262 mammals (1200 of which were domestic sheep) were observed in the transects on or within a 1.6-km (1-mi) boundary of the tracts (Table IV-4). Of this number, 1210 mammals were seen in the shadscale habitat, 21 in both the greasewood and the riparian habitat, and 10 in the juniper habitat.

Rodent-trapping grids were set up, but trapping was stopped because of cold, wet weather. Rodents on the project area cannot survive a cold night in a Sherman trap even with cotton batting and heavy baiting. These same species seem hardier in Montana and western Colorado, where trapping under similar climatic conditions has resulted in much lower mortality rates. Before trapping was halted, one night of trapping was conducted in the shadscale habitat, two in the greasewood and juniper habitats, and none in the riparian habitat. In the five trap nights 79 rodents were captured, 23 of which were marked rodents from August 1975.

Sex identification was a problem in the recaptures. Of the 23 the sex of six kangaroo rats and juvenile mice--was incorrectly identified.

Species Migratory Activity

Twenty-six of the 58 bird species observed migrate to the tracts to nest. The nesting habits of 13 of these species are not fully established. Thirteen of the 58 species are permanent residents. In this group some golden eagles and juncoes migrate out of the area during the nesting season, and three species may or may not be permanent residents. Sandhill cranes and water pipits pass through the area in their northward migration, and Townsend's solitaire migrates from this area to higher elevations. The migrant mammal on tracts is the domestic sheep. Its migratory activity is keyed to temperature and altitude.

Ecological Relationships

An important factor in rodent distribution is soil availability and soil condition. Soil is scarce in the shadscale and juniper habitats. In the shadscale habitat soil is found around the base of shrubs and in eroded rocks filled with soil. Soil in the juniper habitat is found around the base of juniper bushes, sandstone outcrops, and slabs of sandstone that have fallen from the cliffs. Soil is abundant in the greasewood habitat, which dominates the dry washes in the area where soil is carried and deposited. Soil in the riparian habitat is also abundant because of runoff along the White River. The number of rodents captured in three of the vegetation types in August 1975 coincided with soil type and availability: shadscale, 47; juniper, 50; and greasewood, 76. Although soil is available in the riparian habitat, it is apparently unsuitable for rodents, since only 12 were caught. Rodents were trapped in the riparian habitat only in sandy (porous) deposits. The soil under the cottonwoods is silt and clay, which drains poorly and remains wet. The habitat with the densest vegetation supports the least number of rodents.

Mule Deer

Sightings of mule deer are listed in the field data report. By mid-March the deer had returned to the riparian areas along the White River and the adjacent benches, and sub-

sequent sightings were limited to these areas. The home ranges of the deer coincide closely with the ranges established in 1975 by the same deer, indicating a "homing" instinct. As of early June, with fawning imminent, the deer showed the same dependence on the riparian area they showed in 1975.

Mourning Doves

The data derived from the coo-call count routes is contained in the field data report. Included also are data for statewide dove routes for comparison. The methodology of the standardized coo-call count route is from Ruos 1972. Doves counted for the state and tract routes were 27 and 25, respectively. Both figures are higher than the 1975 state-route average of 7 doves and the 1975 statewide average of 12.1 doves per route. The tract route will be monitored biweekly through August as an indication of breeding activity and population levels of mourning doves on the tracts.

Canada Geese

During the earliest float trip in March, 17 pairs and one individual Canada goose were counted from Station S-1 to Station S-11. During the April float trip a total of 37 geese were observed. Of these, 21 were individuals and 17 were paired birds. The decrease in pairs observed during the last census is attributed to the onset of nesting. Many birds were actively nesting and extremely reluctant to fly, preferring instead to hide along the shoreline and on islands in the river.

On May 24 a float trip census from Station S-1 to Station S-11 yielded the first broods of the year. A total of 23 adult birds and broods of 6, 4, and 7 goslings were observed for a total of 40 Canada geese. Several of the adult birds observed hiding in the heavy vegetation along the shoreline were thought to be hiding goslings or still nesting.

Raptors

Table IV-5 lists raptors observed during the last survey. Species observed included the golden eagle, red-tailed hawk, prairie falcon, kestrel, harrier hawk, Cooper's hawk, great horned owl (Figure IV-1), and turkey vulture.

TABLE IV-5

RAPTOR SURVEY SIGHTINGS (MAY 20-24, 1976)

1 Cooper's Hawk	- Cowboy Canyon
2 Golden Eagles	- Cowboy Canyon
1 Kestrel	- Cowboy Canyon
2 Turkey Vultures	- Cowboy Canyon
1 Marsh Hawk	- Wagonhound Canyon
2 Golden Eagles	- 1 mile SE of A-3
2 Kestrels	- Southam Canyon
1 Great Horned Owl	- 1/2 mile E of A-3
1 Prairie Falcon	- Center fork of Asphalt Wash
2 Golden Eagles	- S-12
1 Kestrel	- S-12
2 Kestrel	- A-4
1 Prairie Falcon	- A-11
1 Golden Eagle	- Cowboy Canyon
1 Turkey Vulture	- Hells Hole
2 Turkey Vultures	- X-2
1 Prairie Falcon	- S-4
3 Kestrels	- Asphalt Wash S-12
1 Great Horned Owl	- 1 mile N of S-4
2 Golden Eagles	- 3/4 mile NE of F-5
1 Red-tailed Hawk	- Ignacio
1 Red-tailed Hawk	- Center fork of Asphalt Wash

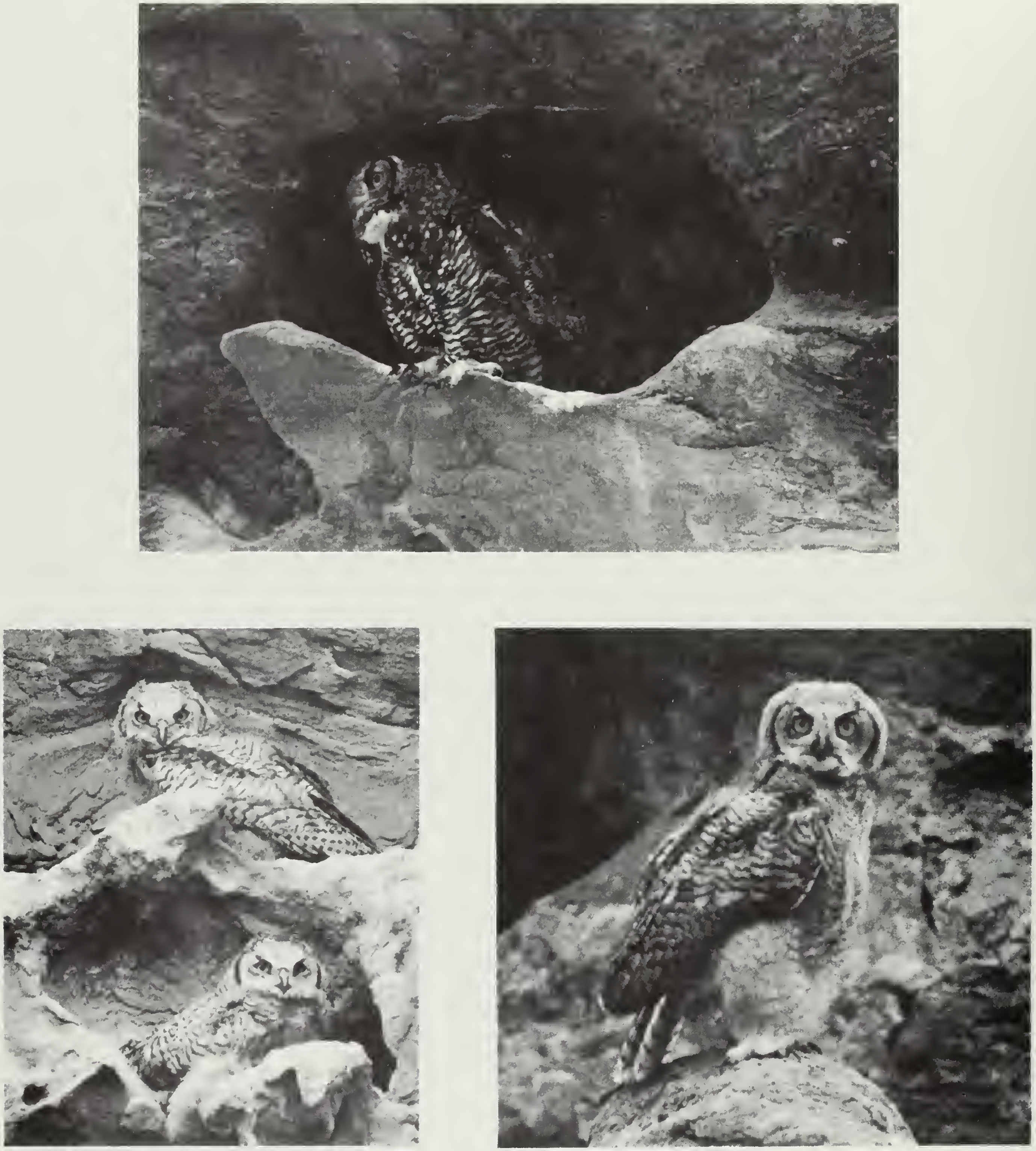


FIGURE IV-1 GREAT HORNED OWL (BUBO VIRGINIANUS), FEMALE AT NEST ENTRANCE AND THREE FLEDGLINGS.

A table and correlated maps included in the field data report list all the active raptor nests observed during the survey. Species observed actively nesting were the golden eagle, Cooper's hawk, great horned owl, and red-tailed hawk. By far the most common nester was the great horned owl, with four active nests. Observations in 1976 indicate that great horned owls are a common nesting bird in this area and that the lack of active nest signtings in 1975 was due to difficulty in locating these inconspicuous nests and not to an absence of breeding birds. A typical nest site was in a hole in a flat-faced rock wall from 3 m to 6.1 m (10 ft to 20 ft) above the ground. Two of the nests were in the riparian habitat and two were in higher, upland sagebrush-shadscale types, all on south exposures. Owl nests are often inconspicuous because of a lack of white washing or nesting materials often found at the nest sites of other raptors. It is felt that because of the abundance of suitable habitat, much of which is highly inaccessible, there may be other owl nests in the area.

Two Cooper's-hawk nests were located during the survey, both in cottonwood trees in the riparian habitat. One bird was using a nest that was used by a long-eared owl in 1975. The other nest was new, near Station X-2, and contained two downy young.

Two active golden-eagle eyries were located in 1976, both in high, inaccessible cliffs above the White River. One nest, in Asphalt Wash, is approximately 1.6-km (1-mi) from an eyrie that was active in 1975 but inactive in 1976. This eyrie now contains one partially fledged young bird. With the large territories established by breeding golden eagles, it is possible that these are the same birds that nested at the other site in 1975, especially since the 1975 site is in a high ledge above and directly visible from water monitoring Station S-11, a site of human activity, and the 1976 site is on a ledge not visible from any road or activity center and in fact can be seen only from the river of from land after a hike of over 1.6 km and a climb of 180 m (600 ft) over rough terrain. It seems likely that the eagles reacted to the disturbance by relocating their nest site to a more inaccessible area.

One active red-tailed hawk nest was located in 1976 in Asphalt Wash. This nest is approximately 1.6 km from a nest site that was active in 1975 but inactive in 1976. This could be an alternate nest site for the same breeding pair, but this is impossible to determine conclusively. A red-tailed hawk nest at Ignacio that was active and successful in 1975 was unoccupied in 1976. A red-tailed hawk was observed in the cliffs above this site, but no territorial behavior was displayed.

No active prairie falcon nests were located during the survey. A nest that was active and successful in 1975, near meteorological Station A-11 (southwest U-b), was inactive in 1976. One prairie falcon was observed perching near the site, but no display that would indicate nesting activity was observed. The cause for abandonment of this nest by the prairie falcon, a bird with strong tendencies to return to successful nest sites, is unknown; the reason could relate to increased human activity, since this site is in a well traveled portion of the tract and is visible from two different roads. Also, core hole drilling was initiated this quarter less than 2 km northwest of the site.

Browse Transects

The most heavily browsed vegetation type observed during the study was the greasewood-sage. This type is characteristic of the bottoms of the larger washes and canyons of the project area and is typically a preferred grazing area for wintering sheep. The total average browse use of sage and greasewood in this type was 21% and 34%, respectively.

The least heavily browsed vegetation type was the juniper-sage, characteristically found at higher elevations, in rocky areas. Field observations on the project area indicate that this type is used by deer for winter range. Sheep use, although light, was evident in most of this type. Browse use for sage and greasewood was 11% and 4%, respectively.

Although the remaining two vegetation types--riparian and sagebrush--are very different in composition, they had similar browse-use levels. Sage and greasewood averaged 11% and 23%, respectively, in the sage-shadscale habitat; and 12% and 24%, respectively, in the riparian habitat. These levels are between the levels of the first two types. One factor not evident in the data but is inherent in the methodology of Cole transects may aid in clarifying this. The levels of utilization are percentages of the previous year's growth used; thus, a 24% utilization of greasewood in the riparian area, where production of vegetation is high, would be a much larger amount of forage consumed than would be a 24% level of use in the sage-shadscale, a more xeric and unproductive type.

Data compiled during this study are included on Tables IV-6 and IV-7. Map locations are included in the field data report.

TABLE IV-6

COLE TRANSECT DATA

Site	Vegetative Type	Use: Artemisia	Sarcobatus	Remarks
1	Riparian	8%	41%	Heavy Sheep Use
2	Juniper-sage	4%		Low Sheep Use
3	Sage-shadscale	1%		Low Sheep Use
4	Sage-shadscale	10%	25%	Moderate Sheep Use
5	Sage-shadscale	16%	23%	Moderate Sheep Use
6	Sage-shadscale	3%		Low Sheep Use
7	Sage-shadscale	5%		Low Sheep Use
8	Sage-shadscale	2%		Low Sheep Use
9	Riparian	14%	32%	Heavy Sheep Use
10	Riparian	14%	2%	Low Sheep Use
11	Greasewood-sage	31%	30%	Heavy Sheep Use
12	Sage-shadscale	17%		Moderate Sheep Use
13	Juniper-sage	47%		Heavy Sheep Use
14	Juniper-sage	9%	2%	Low Sheep Use
15	Juniper-sage	8%	0%	Low Sheep Use
16	Riparian	12%		Moderate Sheep Use
17	Greasewood-sage	3%	11%	Low Sheep Use
18	Juniper-sage	6%		Low Sheep Use
19	Juniper-sage	4%	1%	Low Sheep Use
20	Greasewood-sage	14%	50%	Heavy Sheep Use
21	Juniper-sage	6%	15%	Moderate Sheep Use
22	Greasewood-sage	5%	12%	Moderate Sheep Use
23	Greasewood-sage	34%	50%	Heavy Sheep Use
24	Juniper-sage	8%		Low Sheep Use
25	Riparian	16%	31%	Heavy Sheep Use
26	Riparian	3%	2%	Low Sheep Use

TABLE IV-6 (Cont.)

Site	Vegetative Type	Use: Artemisia	Sacrobatus	Remarks
27	Greasewood-sage	2%	44%	Heavy Sheep Use
28	Riparian	25%	38%	Heavy Sheep Use
29	Sage-shadscale	31%	20%	Heavy Sheep Use
30	Greasewood-sage	40%	51%	Heavy Sheep Use
31	Greasewood-sage	38%	25%	Heavy Sheep Use
32	Riparian	7%	24%	Moderate Sheep Use

TABLE IV-7

AVERAGE UTILIZATION BY VEGETATIVE TYPE

Vegetative Type	Artemisia	Sarcobatus
Riparian	12% (8)	24% (7)
Juniper-sage	11% (8)	4% (4)
Sage-shadscale	11% (8)	23% (3)
Greasewood-sage	21% (8)	34% (8)

REFERENCES

Ruos, James. 1972. Mourning dove status report. Bureau of Sport Fisheries and Wildlife Special Scientific Report. Wildlife No. 176. Washington, D.C. 1974.

3. TERRESTRIAL INVERTEBRATES

Determinations are still not sufficient for meaningful counts of the species sampled for abundance. It is expected that such counts can be made in the fall quarter. The following are the species determinations made during the quarter (Table IV-8).

4. AQUATIC BIOLOGY

Plankton

Plankton was sampled as usual with an alpha sampler and hand-held plankton net. As in the past, the plankton consisted almost entirely of diatoms and occasional cells of green or bluegreen algae and little zooplankton. In general, community composition was similar to that of earlier sampling, with the minor shifts in the order of dominance that are usual with changes in the seasons. *Navicula* (*tripunctata*?) was the most abundant diatom, followed by the usually rare to infrequent *Epithemia sorex* and *Gomphonema olivaceum*. The normally abundant *Cocconeis placentula* was rarely encountered in the samples, perhaps because its most commonly used substrate, *Cladophora glomerata*, was at a low seasonal ebb. *Pleurosigma* and *Cymatopleura* spp. were much more common than in the past. *Phormidium* sp., a blue green algae, appeared infrequently, although it was abundant as periphyton. Cell counts ranged from 14 cells/ml to 62 cells/ml in the White River (Table IV-9), well within the range of earlier samples (7,800 cells/liter to 79,000 cells/liter) and comparable to the 19,000 cells/liter found in April 1976.

Periphyton

Periphyton samplers were removed in November after the ice thawed. No data were collected during winter. Samplers

TABLE IV-8

INSECTS OF OIL SHALE TRACTS U-a AND U-b

HYMENOPTERA

Bethyllidae (determinations by Howard Evans)

Epyris rufipes Say
Epyris clarimontis Kieffer
Epyris sculleni Evans

Pseudisobrachium foutsi Evans

Parasierola #1
Parasierola #2

DIPTERA

Chloropidae (determinations by Curtis Sabrosky)

Thaumatomyia rubida (Coquillet)
Thaumatomyia pullipes (Coquillet)
Thaumatomyia appropinqua (Adams)
Thaumatomyia pulla (Adams)
Thaumatomyia glabra ? (Fallen)

Lasiosina similis (Malloch)
Lasiosina approximatonervis (Zetterstedt)

Chlorops lituratus Adams
Chlorops sp #1
Chlorops sp #2

Diplotoxa recurva Adams
Diplotoxa nr. inclinata Becker
Diplotoxa nr. versicolor Loew

Meromyza nr. pratorum Meigen
Meromyza communis Fed.

Hippelates pusio Loew
Hippelates montanus Sabrosky
Hippelates sp #1 (undescribed)

Elachiptera nigriceps (Loew)

Eribolus nana (Zetterstedt)

Fiebrella sp #1 (undescribed)

TABLE IV-8 (Cont.)

Oscinella coxendrix (Fitch)
Oscinella frit (Linnaeus)
Oscinella hesperia Sabrosky
Oscinella virgata (Coquillet)
Oscinella sp #1 (undescribed)
Oscinella sp #2 (undescribed)

Siphonella nigripalpis Malloch
Siphonella neglecta Becker

Conioscinella sp #1 (undescribed)

Olcella parva (Adams)
Olcella provocans (Becker)
Olcella punctifrons (Becker)
Olcella projecta (Malloch)
Olcella sp #1 (undescribed)

Aphanotrigonum sp #1 (undescribed)

Asteidae (determinations by Curtis Sabrosky)
Asteia multipunctata Sabrosky

Philebosotera setipalpis Sabrosky

Actiosoma sp #1 (undescribed)

Drosophilidae (determinations by Willis Wirth)
Drosophila novamexicana Patton
Drosophila sp #1

Scaptomyza pallida Zetterstedt
Scaptomyza flavelola (Meigen)

Milichiidae
Milichiella arcuata (Loew)
Milichia sp #1 (undescribed)
Milichia sp #2 (undescribed)

Eusiphona mira Coquillet

Leptometopa sp #1 (undescribed)
Leptometopa latipes sp #2 (undescribed)

Madiza glabra Fallen

Desmometopa tarsalis Loew

TABLE IV-8 (Cont.)

Carnidae (formerly in Milichiidae) determinations by Curtis Sabrosky

Hemeromyia obscura Coquillet
Hemeromyia washingtona Melander

Meoneura polita Sabrosky
Meoneura sp #1 (undescribed)

TABLE IV-9

PHYTOPLANKTON COUNTS

Station No.	1	2	3	4	6*
Counts (Cells/ml)	25.9	14	20.2	11.6	3.8
	33.2	35.9	21.3	14.6	3.7
	36.5	61.9	30.4	15.8	
Average	31.9	37.3	24	14	3.7

Composite average = 26.8 cells/ml (26,800 cells per liter)

Confidence level = 80%

*Evacuation Creek

were replaced in the river and in Evacuation Creek during March, and the sample strips were changed after four weeks. Samples are being analyzed by the USGS Laboratory. The results will be reported when they are available.

Qualitative examination of periphyton indicated that the community composition was similar to that of the past. *Cladophora glomerata* was sparse, occurring as short, isolated clumps on shallowly submerged stones. *Phorimidium* sp. occurred as a crust of short filaments and appeared to be the dominant periphyte.

Macroinvertebrates

Invertebrates were sampled by kickscreen (Figure IV-2), Surber sampler, and Ekman dredge, as described in the fourth quarterly report. Several species of stoneflies emerged during the mid-March sampling. Of these, *Oemopteryx fosketti*, *Taenionema* (*pacifica*?) and *Capnia* (2 spp.) were the most common. The stream-gaging stations provide an ideal spot for stoneflies to congregate after emergence, and hydrographers report finding them there through most of the winter.

Invertebrate sampling locations were changed at stations F-1 and F-3. The F-1 station was unsuitable for sampling

FIGURE IV-2 VTN AQUATIC BIOLOGIST USING KICKSCREEN.

FIGURE IV-3 WHITE RIVER MEANDER AT STATION F-1 (UPPER CENTER).

because the March discharge rate was 700+ cfs and a thick accumulation of sand had obliterated most of the invertebrates at the regular Station F-3 sampling point. Samples were taken from Station F-1 at a perennial meander that leaves the main channel directly across from the mouth of Hell's Hole Canyon (figures IV-3 and IV-4), and Station F-3 was sampled immediately above the Bonanza Bridge. Other stations were sampled at regular locations.

Invertebrate densities were considerably higher at the altered sampling points than at the other stations. Surber samples averaged 110 organisms and 74 organisms at stations F-1 and F-3, respectively, compared with 8.6, 12.4, and 22.3 at the other stations. The apparent clumping of populations reflected by Surber-sampler data (Table IV-10) may be partially due to substrate changes caused by ice jams. The populations at Station F-2 were abnormally low. Although the long riffle (Figure IV-5) provides ideal substrate, a dense population was not found. The riffle is shallow, and thick ice cover may have caused invertebrates to abandon the area during winter. If this was the case, the population will soon attain normal levels as the riffle becomes repopulated.

Kickscreen samples (Table IV-11) generally verified the trends indicated in the Surber sampling. The kickscreen (Figure IV-2) can be used in much deeper, faster water and can sometimes collect unusual specimens (Figure IV-6).

Diversity indices (Table IV-12) averages are nearly the same as for earlier samples. Composite and individual indices were calculated to show the effect of increased sample size.

The Ekman sampling procedure was changed slightly in an effort to increase sampling validity. A total of 10 Ekman samples were combined to form one composite sample from each station. Sample data (Table IV-13) show this strategy was somewhat successful.

Fishery

The fishery was not studied during the March sampling period. In a meeting with the Division of Wildlife Resources in Vernal it was stated that sampling of the White River fishery may be in violation of the Code of Federal Regulations, which forbids capturing or harassing threatened or endangered species or disturbing their habitat. Sampling has been delayed pending clarification of the code, although it now appears that sampling is permissible within the laws governing such activity.

FIGURE IV-4 STATION F-1 MEANDER LOOKING DOWNSTREAM. SAMPLING SITE OUTLINED.

FIGURE IV-5 STATION F-2, DOWNSTREAM VIEW FROM LEFT BANK.
SAMPLING SITE OUTLINED.

TABLE IV-10

WHITE RIVER MACROINVERTEBRATES: SURBER DATA SUMMARY; MARCH, 1976

Sample No.	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
Station No.			1					2					3					4					5			Total
EPHEMEROPTERA																										
Heptagenia elegantula	7	1	57	50		3					3	1	3	5	2		1			1	1	3				138
Rhithrogena undulata	9	14	4	1	4	2		2			22	19	6	16	34						4	5	4		3	149
Baetis (tricuadatus ?)	24	8	3	6	3	1		1			7	3	3	10	7		2	1		1	4	3	3		7	97
Baetis sp.	2																									2
Ephemerella (inermis?)	79	12	83	16	21	8		1			24	18	16	36	32		2			1	5	2	2	2	5	365
Ephemerella sp.											1															1
Tricorythodes minutus				5																					2	7
PLECOPTERA																										
Oemopteryx fosketti	3	3				9					1		2	2	1	1		2		2	3				1	31
Taenionema (pacifica?)	1					1					1		1		1									1		6
Capnia vernalis	1	1		1			1	1	1		1	1	2	2	1	2	7					1	2			25
Capnia sp.		2		1	1						1	1		1	1	9	30			1	1	1	1	1	2	54
Isogenus (Isogenoides) frontalis	4	3	4	2	2			1		2		2		4	4		1								1	30
ODONATA																										
Ophiogomphus severus		2											2						1							5
Hetaerina sp.																						2				2
TRICHOPTERA																										
Hydropsyche sp.			9	1	2					1			2										2			17
Cheumatopsyche sp.	5		20	3				2			13	4	5	9						1	2	3			7	74
Leptocella sp.																		1								1
COLEOPTERA																										
Hygrotus sp.																1										1
Elmidae											1															1
DIPTERA																										
Simulium (?) sp.		2		1							5				4											12
Hexatoma sp.																						1				1
Palpomyia (?) sp.											1				1									1	1	4
Chironomidae														4												4
Chironomus sp. A	17			5	2	1	1	1		1	2		1	4	5	1	1	2		1	3	5	1		1	55
Chironomus sp. B				1																						1
Crictopus (?) sp.	2	1	6								1		1	1											1	13
Orthocladius (?) sp.		6	25					1					1										3		5	41
Atherix variegata								1																		1
Empididae														2	1											3
ANNELIDA																										
Limnodrilus claparedianus				1														1								2
Naididae	1													1												2
Total/ft^2	155	55	211	94	35	25	2	11	1	4	84	49	45	97	94	14	44	7	2	5	23	25	22	5	36	
Total/m^2	1668	592	2271	1012	377	269	22	118	11	44	904	527	484	1044	1012	151	474	75	22	54	248	269	237	54	388	1145

TABLE IV-11

MACROINVERTEBRATE DATA, WHITE RIVER, UTAH; KICKSCREEN SAMPLES, MARCH, 1976

Station No.	1					2					3					4					5					
Sample No.	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	Total
Ephemeroptera																										
Heptagenia elegantula	23	4	1	2	43	7					9	5	7	12	8	10	7	1	3	7						140
Rhithrogena undulata	25	39	22		15	1	7	2	8	1	4	4	20	18	10				2		19	8	7	20	11	244
Baetis tricaudatus	3	1			2	2								5	4	1				1		1	1		1	222
Ephemerella inermis	85	73	12	24	89	20	4	5		2	20	29	58	112	58	19	19	17	16	18	4	20	7	10	7	728
Ephemerella sp.			1																							1
Ametropus (albrighti ?)											1				1											2
Odonata																										
Gomphus intricatus	1													1												2
Ophiogomphus severus	3	1			4						1		1	5	5	4	3		2	3						32
Coenagrionidae																			1							1
Plecoptera																										
Oemopteryx fosketti	4	4	3		2	5	4	3		1	3	2		1	9	4	1	8	2	2		1		4		64
Taenionema pacifica	2	2									3			1							4	6	1		1	20
Capnia (vernalis ?)		3		4		7	1	1	1	1			1	5	2	1		1	3		1	1	1	1		36
Capnia sp.	1	3	2	2		5	1			1		3	5	3		4		3	4		1		2			41
Isogenus (Isogenoides) frontalis	6	8	7	1	7		3	3	1		8	1	2	8	5	2	2		3	1	12	4	3	6	1	91
Acroneuria abnormis															3											3
Megaloptera																										
Corydalis (cognata ?)																								1		1
Trichoptera																										
Hydropsyche sp.	7	18		1	99	1		1		1	2	5	3	6	3	1	1		2			1	1	4	2	158
Cheumatopsyche sp.	2	18			8	2				4	2	2	8	22	7	2	2	1	3	2	12	6	9	2		112
Leptocella (alba ?)												1								3						4
Limnephilidae					1																					1
Brachycentrus sp.												1					1			1						3
Lepidoptera																										
Pyralidae											1	1														2
Coleoptera																										
Elmidae												1									1					2
Diptera																										
Tipulidae *(hexatoma sp.)*	1				1																1			1	1	5
Blephariceridae *(bibiocephala ?)* sp.											1		1													2
Simuliidae *(Simulium sp.)*	1											2		2			1			1					1	8
Chironomidae		1	3			5														4	1				1	15
Chironomus sp. A	9		1	8		3					2	2	1			2	2		1	2		3				36
Chironomus sp. B											3											1				4
Cricotopus					3																					3
Orthocladius	2	2			30								2	6			4									46
Tanytarsus												3		3												6
Ceratopogonidae *(Palpomyia ?)* sp.		1									1			1											1	4
Atherix variegata	1	3			5						2		3			1					1					16
Empididae											3	2			1						1					7
Syrphidae																							1			1
Anthomyiidae																								1		1
Cyclorapha (pupae)																								1	1	2
Gordius (?) sp. (Nematomorpha)				1																				1	1	3
Annelida																										
Limnodrilus claparedianus						1						1											1			3
Naididae					1																					1
Number/ft^2	177	181	52	43	310	61	20	15	10	11	66	65	112	207	116	51	43	31	42	46	58	51	33	51	29	1880
Number/m^2	1905	1948	560	463	3337	657	215	161	108	119	710	700	1206	2228	1240	549	463	334	452	484	624	549	355	549	312	

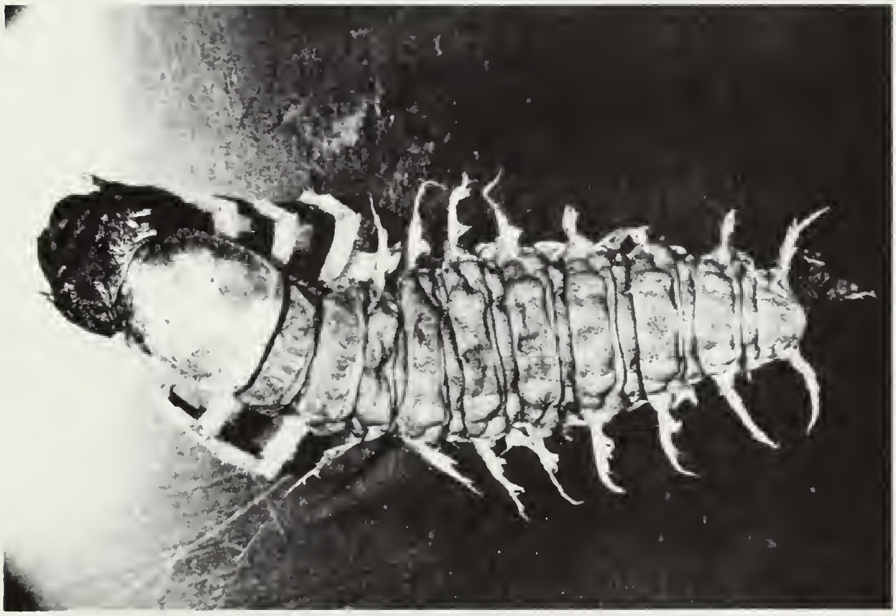


FIGURE IV-6 CORYDALUS SP., A LARGE DOBSONFLY LARVA (APPROXIMATELY 1.3X). RARE IN WHITE RIVER.

TABLE IV-12

SPECIES DIVERSITY ($\bar{d}$) INDICES OF BENTHIC INVERTEBRATES
BY SHANNON WEAVER FUNCTION.
WHITE RIVER UTAH, MARCH 1976 SURBER SAMPLES

Station	Sample No.	SDI	N*	Y**
F-1	1	2.41	155	13
	2	3.12	56	13
	3	2.37	211	9
	4	2.39	94	14
	5	1.96	35	7
	Composite	2.93	553	20
F-2	1	2.27	25	7
	2	1.00	2	2
	3	3.10	11	9
	4	0.0	1	1
	5	1.50	4	3
	Composite	3.37	43	14
F-3	1	2.89	84	15
	2	2.13	49	8
	3	3.08	45	13
	4	2.96	97	14
	5	2.49	94	13
	Composite	2.96	368	22
F-4	1	1.46	14	5
	2	1.58	44	6
	3	2.24	7	5
	4	1.00	2	2
	5	2.32	5	5
	Composite	2.46	72	14
F-5	1	2.94	23	9
	2	2.98	25	9
	3	3.54	22	10
	4	1.92	5	4
	5	3.19	36	12
	Composite	3.60	111	16

average sample $\bar{d}$ = 2.272
*N = Number of invertebrates per ft ($0.093m^2$)
**Y = Number of taxa per sample

TABLE IV-13

EKMAN DREDGE DATA, MARCH, 1976

Data shown are composites of 10 samples at each station

Station	1	2	3	4	5
Ephemeroptera					
Heptagenia elegantula		1			2
Baetis (tricaudatus ?)			1		
Ephemerella inermis	1	4	3		
Ametropus albrighti			1		1
Tricorythodes sp.					
Plecoptera					
Taenionema (pacifica ?)			1		
Capnia vernalis			2		
Capnia sp. A				4	
Odonata					
Ophiogomphus severus		3	2		3
Diptera					
Tipulidae		4	3		
Simuliidae					2
Ceratopogonidae	7	9	30	4	
Chiornomidae					
Diamesia (?) sp.	79		17	6	13
Chironomus sp.		358	24	45	44
Stichtochironomus sp.			7	5	
Parachironomus			1		11
Paratendipes (?) sp.	3		2		
Cryptochironomus sp.		13	13	5	9
Orthocladius (?) sp.					4
Empididae		4	2		5
Annelida					
Limnodrilus claparedianus	27	11	9	46	31
Total	117	407	121	115	127
Average No./m^2	499	1752	603	2373	547
Average No./ft^2	46.8	162.8	48.4	46	50.8

5. MICROBIOLOGY

In general the increased moisture availability observed over the 1976 spring sampling dates are reflected in the generally high metabolic values determined by respiration, ATP, and dehydrogenase activity assays. The low C/N ratios and high microbial group counts indicate that active decomposition and ensuing metabolic functions are at a high point in the spring. Generally, all parameters are at levels analogous or higher to those observed in spring 1975.

Vegetation Descriptions

The following are descriptions of the vegetation of the sampling sites used in the microbiology program. The sites are designated on a map that was included in the First Year Environmental Baseline Report.

The most prevalent vegetation at Site 39 are *Boraginaceae*, *Bromus tectorum*, *Tetradymia spinosa*, *Stipa comata*, and *Artemisia tridentata*. Less dominant species include *Grayia spinosa*, *Chrysothamnus nauseosus*, *Sarcobatus vermiculatus*, and *Artemisia nova*.

The most prevalent vegetation at Site 50J, the juniper vegetation area, is *Juniperus osteosperma*. Litter samples are collected exclusively under its canopy. *Sarcobatus vermiculatus*, *Chrysothamnus nauseosus*, *Stipa comata*, *Hilaria jamesii*, and *Artemisia tridentata* comprise the other major vegetation types.

Site 58, the shadscale vegetation area, comprises mainly *Bromus tectorum*, *Chrysothamnus viscidiflorus*, *Artemisia tridentata*, *Chrysothamus grunei*, and *Chorispora tenella*. Other vegetation includes *Atriplex confertifolia*, *Sarcobatus vermiculatus*, *Tetradymia spinosa*, and *Opuntia* spp.

The cover and densities at the riparian site (55R) are about twice those of the other three sites, mainly because dense stands of downy brome (*Bromus tectorum*) and western wheatgrass (*Agropyron smithii*) occur. Annual mustards and yellow-blossom sweet clover (*Telilotus officinalis*) are also a significant portion of the high-ground cover. Other vegetation includes *Atriplex canescens*, *Populus fremontii*, *Sarcobatus vermiculatus*, *Kochia* spp., and *Distichlis spicata*. Conspicuously higher microbial activities measured at this site reflect its higher nutrient content and favorable moisture conditions.

Microbial Numbers

The number of microbes found at the various sites are shown in tables IV-14 through IV-17. Litter samples yielded the highest microbe counts, with bacterial and streptomycetes the most abundant at Site 58 and litter and fungi the most abundant in the juniper litter at Site 50J.

At all sites more microbes were found 0 cm to 3 cm beneath the ground surface, except at Site 58, where greater numbers occurred at 5 cm to 20 cm for aerobic bacteria and 40 cm to 50 cm for fungi. Moisture availability and aeration are probably the factors determining populations encountered at the different depths. Microbes were slightly more abundant in spring of 1975, reflecting better moisture and substrate availability at the beginning of spring 1976.

Dehydrogenase Activity

Biological activity as measured by the dehydrogenase assay was greater in litter samples collected in March 1976. Considerable activity was also noted in juniper and riparian soils. The values indicate that activity, although greatest at the surface, was fairly consistent throughout the soil profile in the spring. Values at all sites decreased from mid-March to late April 1976 and were considerably higher overall in spring 1975. Dehydrogenase data are listed on Table IV-18.

Respiration

Metabolic activity (the release of CO_2) increased from March to April 1976 at all sites except at Site 58, where a decrease was noted. Site 58I, in fact, displayed a significant decrease in the first 3 cm from March to April, dropping from about 16 μmoles CO_2/g/min to 3 μmoles CO_2/g/min. The decrease at Site 58I is consistent throughout the profile. Litter samples displayed the most metabolic activity, especially those of the riparian site (55R). On the average, soil respiration was somewhat lower than that recorded over the same period in spring 1975. Metabolic-activity values are shown on Table IV-19.

TABLE IV-14

AEROBIC BACTERIA

Number Per Gram of Soil

Sample	18 March 1976	26 April 1976
39-1	6.78×10^6	3.74×10^6
39-2	4.40×10^6	8.84×10^5
39-3	3.60×10^5	7.04×10^5
50JC-1	5.30×10^6	6.46×10^6
50JI-1	5.70×10^6	9.16×10^6
55R-1	2.12×10^7	1.51×10^7
55R-2	5.84×10^6	2.33×10^6
55R-3	3.58×10^6	8.60×10^6
58C-1	4.26×10^6	1.06×10^7
58C-2	7.16×10^6	1.33×10^7
58C-3	4.10×10^6	7.50×10^6
58I-1	5.52×10^6	2.30×10^6
58I-2	1.67×10^7	3.80×10^6
58I-3	6.90×10^6	2.70×10^6
50J-L	1.34×10^7	-
58-L	6.50×10^7	-

TABLE IV-15

ANAEROBIC BACTERIA

Number Per Gram of Soil

Sample	18 March 1976	26 April 1976
39-1	5.80×10^3	6.10×10^3
39-2	1.50×10^3	4.06×10^3
39-3	1.90×10^3	2.00×10^3
50JC-1	4.42×10^4	6.63×10^4
50JI-1	5.60×10^3	4.16×10^3
55R-1	6.60×10^3	1.14×10^4
55R-2	3.36×10^3	6.50×10^3
55R-3	7.10×10^3	2.90×10^3
58C-1	9.06×10^3	1.93×10^4
58C-2	3.85×10^4	1.21×10^4
58C-3	1.09×10^4	1.28×10^4
58I-1	1.18×10^4	7.30×10^3
58I-2	7.50×10^3	3.70×10^3
58I-3	1.39×10^4	2.80×10^3
50J-L	2.06×10^3	-
58-L	4.17×10^4	-

TABLE IV-16

STREPTOMYCETES

Number Per Gram of Soil

Sample	18 March 1976	26 April 1976
39-1	2.16×10^6	1.50×10^6
39-2	1.46×10^6	1.66×10^5
39-3	2.68×10^5	1.84×10^5
50JC-1	2.00×10^6	1.46×10^6
50JI-1	1.46×10^6	2.18×10^6
55R-1	2.56×10^6	2.70×10^6
55R-2	1.04×10^6	6.04×10^5
55R-3	8.60×10^5	4.40×10^5
58C-1	1.78×10^6	2.34×10^6
58C-2	1.48×10^6	1.30×10^6
58C-3	1.34×10^6	1.70×10^6
58I-1	2.10×10^6	1.70×10^6
58I-2	1.88×10^6	1.20×10^6
58I-3	1.40×10^6	1.60×10^6
50J-L	5.60×10^5	-
58-L	1.30×10^6	-

TABLE IV-17

FUNGI

Number Per Gram of Soil

Sample	18 March 1976	26 April 1976
39-1	2.80×10^4	1.28×10^4
39-2	1.60×10^5	1.80×10^3
39-3	1.00×10^5	3.80×10^3
50JC-1	4.40×10^4	5.04×10^4
50JI-1	5.20×10^4	2.30×10^4
55R-1	3.50×10^6	1.72×10^4
55R-2	3.80×10^5	3.08×10^4
55R-3	3.80×10^4	2.10×10^4
58C-1	3.80×10^5	3.08×10^4
58C-2	3.00×10^4	2.24×10^4
58C-3	4.50×10^5	1.44×10^4
58I-1	8.00×10^4	6.60×10^3
58I-2	3.40×10^4	7.00×10^3
58I-3	2.60×10^5	9.00×10^3
50J-L	3.30×10^6	-
58-L	7.60×10^5	-

TABLE IV-18

DEHYDROGENASE ACTIVITY

Formazan mg/ml

Sample	18 March 1976	26 April 1976
39-1	0.086	0.026
39-2	0.032	0.035
39-3	0.021	0.023
50JC-1	0.766	0.438
50JI-1	0.277	0.179
55R-1	0.271	0.159
55R-2	0.038	0.016
55R-3	0.051	0.016
58C-1	0.160	0.147
58C-2	0.058	0.025
58C-3	0.114	0.018
58I-1	0.081	0.042
58I-2	0.058	0.043
58I-3	0.021	0.038
50J-L	1.789	-
58-L	1.764	-

TABLE IV-19

RESPIRATION

μmoles CO_2/g/min

Sample	18 March 1976	26 April 1976
39-1	23.56	24.58
39-2	15.32	20.18
39-3	17.53	20.29
50JC-1	24.88	55.48
50JI-1	28.28	31.35
55R-1	46.30	44.54
55R-2	26.81	23.85
55R-3	35.91	28.19
58C-1	24.93	18.74
58C-2	22.26	14.51
58C-3	18.22	18.94
58I-1	15.84	2.97
58I-2	21.39	1.47
58I-3	14.45	3.80
50J-L	115.32	-
58-L	89.92	-

Water Potential

Relatively low water potentials were observed throughout March and April. The highest potentials were recorded at 40 cm to 50 cm at Site 58, the 5 cm to 20 cm at Site 39, and at the surface at Site 55R. The lowest potential was recorded at Site 58I, which had a range of from -1.0 bars to -6.60 bars over the sampling period (Table IV-20).

Water potentials were generally lower than those of spring 1975, reflecting higher water availability during this quarter.

Soil-Moisture Content

Moisture-content values, listed on Table IV-21, decreased at all sites from March to April. Moisture content was highest in litter and riparian soil samples and was generally high throughout sites and profiles, reflecting the residual moisture from snowmelt and early spring rains. The high moisture values correspond with the low water potentials and partially explain the relatively high biological activity noted earlier. On the average, moisture content was slightly higher than in spring 1975.

Organic Carbon and Total Nitrogen Content

The best indicator of the relationship between organic carbon and total nitrogen in the soil system is their ratio. The data collected March 18 and April 26 reflect typically low C/N ratios, indicating good decomposition of litter at all sites in spring. The values from these sampling dates correspond closely with those recorded at the same time in spring 1975. Table IV-22 lists the data for these parameters.

Nitrate Content

At all the sites nitrogen in the form of nitrates was conspicuously lower in late April 1976 than at the same time in spring 1975. Nitrate values for March 1975 and 1976 were generally analogous. Overall, values decreased with depth and were significantly higher at sites 55R and 58C. The data indicate the possibility of increased leaching of NO_3. Nitrate-content values are listed on Table IV-23.

TABLE IV-20

WATER POTENTIAL
(DURING RESPIRATION STUDIES)

-Bars

Sample	18 March 1976	26 April 1976
39-1	4.10	2.80
39-2	6.00	15.50
39-3	3.90	16.00
50JC-1	1.00	5.20
50JI-1	2.35	5.00
55R-1	5.60	7.80
55R-2	6.00	4.90
55R-3	3.70	2.60
58C-1	5.00	5.20
58C-2	10.00	7.30
58C-3	14.50	9.20
58I-1	1.00	3.00
58I-2	1.00	3.70
58I-3	2.00	6.60
50J-L	2.00	-
58-L	2.90	-

TABLE IV-21

MOISTURE CONTENT

% Moisture

Sample	18 March 1976	26 April 1976
39-1	15.23	11.35
39-2	16.04	11.83
39-3	15.34	9.73
50JC-1	25.67	13.11
50JI-1	24.87	15.86
55R-1	22.32	21.18
55R-2	19.40	15.51
55R-3	18.33	19.74
58C-1	15.70	6.52
58C-2	7.55	7.50
58C-3	7.50	7.58
58I-1	14.38	12.15
58I-2	12.90	9.08
58I-3	13.30	8.69
50J-L	49.76	-
58-L	20.45	-

TABLE IV-22

ORGANIC CARBON AND TOTAL NITROGEN CONTENT

Sample	18 March 1976			26 April 1976		
	% Org. C	% Total N	C/N	% Org. C	% Total N	C/N
39-1	0.57	0.07	8.1	0.30	0.05	6.0
39-2	0.40	0.05	8.0	0.27	0.04	6.7
39-3	0.30	0.03	10.0	0.23	0.03	7.7
50JC-1	2.26	0.15	15.1	1.35	0.15	9.0
50JI-1	1.07	0.11	9.7	1.18	0.13	9.1
55R-1	1.43	0.11	13.0	1.18	0.09	13.1
55R-2	0.38	0.03	12.7	0.49	0.04	12.2
55R-3	0.56	0.04	14.0	0.54	0.05	10.8
58C-1	0.65	0.05	13.0	0.50	0.06	8.3
58C-2	0.42	0.04	10.5	0.41	0.04	10.2
58C-3	0.45	0.04	11.2	0.23	0.02	11.5
58I-1	0.38	0.04	9.5	0.37	0.05	7.4
58I-2	0.31	0.03	10.3	0.24	0.03	8.0
58I-3	0.32	0.03	10.7	0.28	0.03	9.3
50J-L	19.89	0.44	45.2	-	-	-
58-L	6.49	0.39	16.6	-	-	-

TABLE IV-23

NITRATE CONTENT

$\mu g/g\ NO_3^- - N$

Sample	18 March 1976	26 April 1976
39-1	1.40	1.05
39-2	1.10	0.25
39-3	1.00	0.15
50JC-1	2.00	0.33
50JI-1	0.70	0.40
55R-1	5.40	0.65
55R-2	1.60	0.15
55R-3	0.90	0.03
58C-1	7.60	0.53
58C-2	5.40	0.53
58C-3	4.50	0.35
58I-1	1.60	0.23
58I-2	1.60	0.15
58I-3	2.70	0.28
50J-L	<.1	-
58-L	13.50	-

pH

Data in March and April 1976 are listed on Table IV-24. Values increases slightly at all sites from March 18 to April 26. All were generally consistent with those found in the spring of 1975.

ATP Concentration

Data for ATP concentrations, reported in μg ATP/g dry soil, are listed on Table IV-25. Values recorded March 18, 1976, were slightly lower at sites 39 and 50J but higher at the riparian site (55R) and Site 58 than the values recorded March 1975, indicating a high degree of metabolic activity at the latter sites and somewhat lower activity at sites 39 and 50J. The respiration values support the conjecture that microbial activities are relatively high in the spring, as evidenced by the ATP values.

Ammonium Nitrogen

The values for total, fixed, and exchangeable ammonium nitrogen are listed on Tables IV-26, IV-27, and IV-28, respectively, and the exchangeable NH_4^+-N values are plotted on Figure IV-7.

The data indicate that exchangeable NH_4^+ is most available in early spring and that virtually all NH_4^+ in the soil system is fixed during summer. In the fall, exchangeable ammonium is released to the system with increased fall moisture availability. The data also suggest high rates of nitrification occur in spring and autumn months, when virtually all available NH_4^+ is oxidized to nitrates, with low rates in summer.

Nitrogen (N_2) Fixation

Nitrogen-fixation data, expressed as grams of nitrogen fixed per hectare per 24 hrs, are listed on Table IV-29, and plotted on Figure IV-8. With the exception of Site 55R all sites showed higher rates of fixation in mid-spring and early autumn. Although peaks do not coincide, a definite pattern of measurable fixation is evident through late spring and summer for each site.

TABLE IV-24

pH VALUES

Sample	18 March 1976	26 April 1976
39-1	8.48	9.00
39-2	8.56	7.90
39-3	8.24	7.70
50JC-1	8.13	8.20
50JI-1	8.35	8.00
55R-1	8.31	8.20
55R-2	8.30	8.20
55R-3	8.10	8.40
58C-1	8.48	9.90
58C-2	8.50	9.60
58C-3	8.85	9.70
58I-1	8.36	8.20
58I-2	8.84	9.00
58I-3	8.50	9.30
50J-L	8.00	-
58-L	8.25	-

TABLE IV-25

ATP CONCENTRATION

μg/g Dry Soil

Sample	18 March 1976
39-1	0.0019
50JC-1	0.0401
50JI-1	0.0179
55R-1	0.0597
58C-1	0.1412
58I-1	0.0537

TABLE IV-26

TOTAL AMMONIUM (NH_4^+) NITROGEN

μg N/g Soil

Sample	6 November 1975	18 March 1976	26 April 1976
39-1	34.54	24.60	17.94
39-2	11.44	27.21	18.00
39-3	9.16	19.38	15.36
50JC-1	119.5	109.9	109.6
50JC-2	-	-	-
50JI-1	1005.	81.29	96.54
50JI-2	-	-	-
55R-1	64.03	74.49	67.87
55R-2	-	17.55	21.02
55R-3	23.00	29.82	20.12
58C-1	32.21	30.78	30.57
58C-2	9.04	22.21	19.57
58C-3	11.93	19.56	10.54
58I-1	24.71	18.13	27.49
58I-2	16.12	18.97	13.75
58I-3	14.13	15.07	15.98
50J-L	335.4	227.5	-
58-L	119.3	228.5	-
55-L	-	-	-

TABLE IV-27

FIXED AMMONIUM NITROGEN

μg N/g Soil

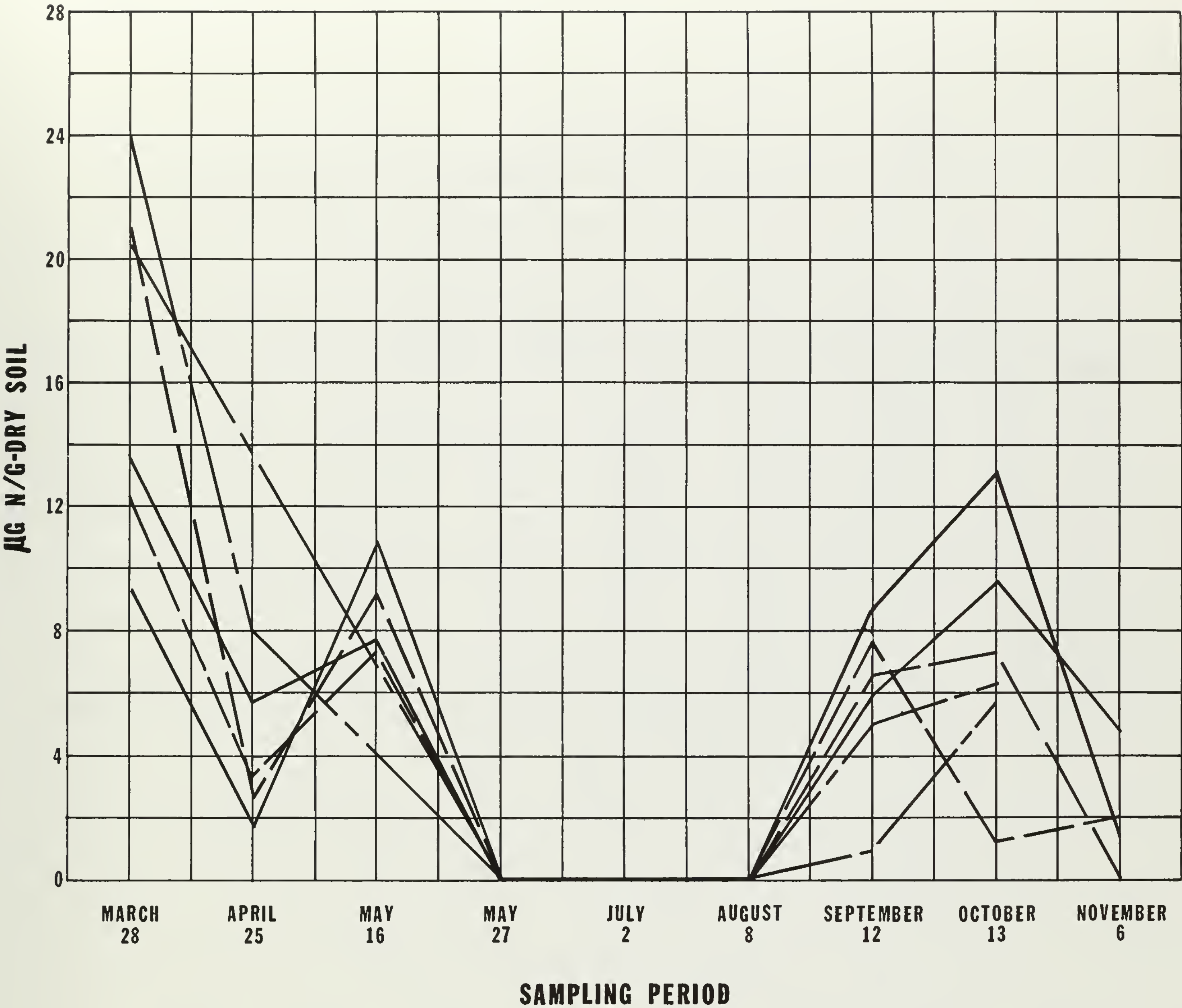
Sample	28 March 1975	25 April 1975	16 May 1975	27 May 1975	2 July 1975	8 August 1975	12 Sept. 1975	13 Oct. 1975	6 Nov. 1975
39-1	18.71	37.31	43.36	14.27	27.29	30.90	25.73	15.43	29.78
39-2	4.50	14.24	24.14	13.22	12.48	29.80	20.35	5.27	10.55
39-3	0	3.79	17.73	8.95	15.54	19.90	16.94	9.92	10.82
50JC-1	79.81	56.40	72.95	68.46	71.49	93.20	54.32	91.20	118.0
50JC-2	91.04	65.27	-	-	-	111.3	-	-	-
50JI-1	38.75	66.06	80.77	92.25	84.85	75.80	79.13	98.48	1005.
50JI-2	30.98	74.74	80.13	54.85	-	99.60	-	-	-
55R-1	38.47	28.20	46.62	50.49	73.15	47.00	7.63	61.43	-
55R-2	0	8.66	11.33	4.84	37.88	11.60	15.27	-	-
55R-3	0	0	0	8.92	37.01	10.17	38.33	20.46	23.00
58C-1	21.24	-	-	-	41.25	59.78	46.90	26.71	-
58C-2	0	-	-	-	13.29	31.47	38.97	10.16	-
58C-3	0	-	-	-	13.79	30.13	56.32	9.32	-
58I-1	18.29	22.64	23.84	21.74	36.02	17.26	22.25	17.53	23.91
58I-2	0	9.28	7.83	9.20	17.22	13.32	20.18	14.58	15.68
58I-3	0	10.88	4.68	6.40	15.72	8.08	11.96	0.75	14.13
50J-L	318.9	-	-	-	-	-	30.51	-	-
58-L	-	-	-	-	-	-	-	-	-
55-L	-	-	-	-	-	-	-	-	-

TABLE IV-28

EXCHANGEABLE AMMONIUM NITROGEN

μg N/g Soil

Sample	28 March 1975	25 April 1975	16 May 1975	27 May 1975	2 July 1975	8 August 1975	12 Sept. 1975	13 Oct. 1975	6 Nov. 1975
39-1	9.40	1.67	10.84	0.06	0	0	5.88	9.58	4.76
39-2	14.37	2.42	8.85	0.06	0	0	3.70	6.03	1.51
39-3	12.24	10.49	11.76	0.03	0	0	5.16	1.53	0
50JC-1	13.48	5.68	7.84	0.08	0.02	0	8.60	13.03	1.53
50JC-2	12.00	6.62	-	-	-	0	-	-	-
50JI-1	21.14	2.54	9.23	0.06	0.04	0	6.53	7.32	0
50JI-2	17.46	3.40	9.43	1.00	-	0	-	-	-
55R-1	12.35	3.19	7.77	0.09	0	0	7.63	1.27	1.78
55R-2	11.07	6.53	10.91	0.08	0	0.06	4.97	-	-
55R-3	14.80	12.16	23.54	0.07	0	0.06	3.62	1.06	0
58C-1	20.74	-	-	-	0.02	0.04	5.05	6.29	-
58C-2	32.00	-	-	-	0.04	0.04	0	6.03	-
58C-3	16.00	-	-	-	0.02	0.04	0.73	5.97	-
58I-1	24.19	7.96	7.03	0.02	0	0.04	2.25	4.79	0.80
58I-2	14.48	4.72	14.11	0.09	0.02	0.04	0.72	0	1.53
58I-3	7.63	6.09	10.91	0.08	0	0.06	0	7.43	0
50J-L	30.29	-	-	-	-	-	3.05	1.55	-
58-L	-	-	-	-	-	-	-	7.25	-
55-L	-	-	-	-	-	-	-	-	-



SITE LEGEND

—— 39	– – – 55R
—— 50JC	– – – 58C
– – – 50JI	– · – 58I

EXCHANGEABLE AMMONIUM NITROGEN - 1975

SURFACE ONLY

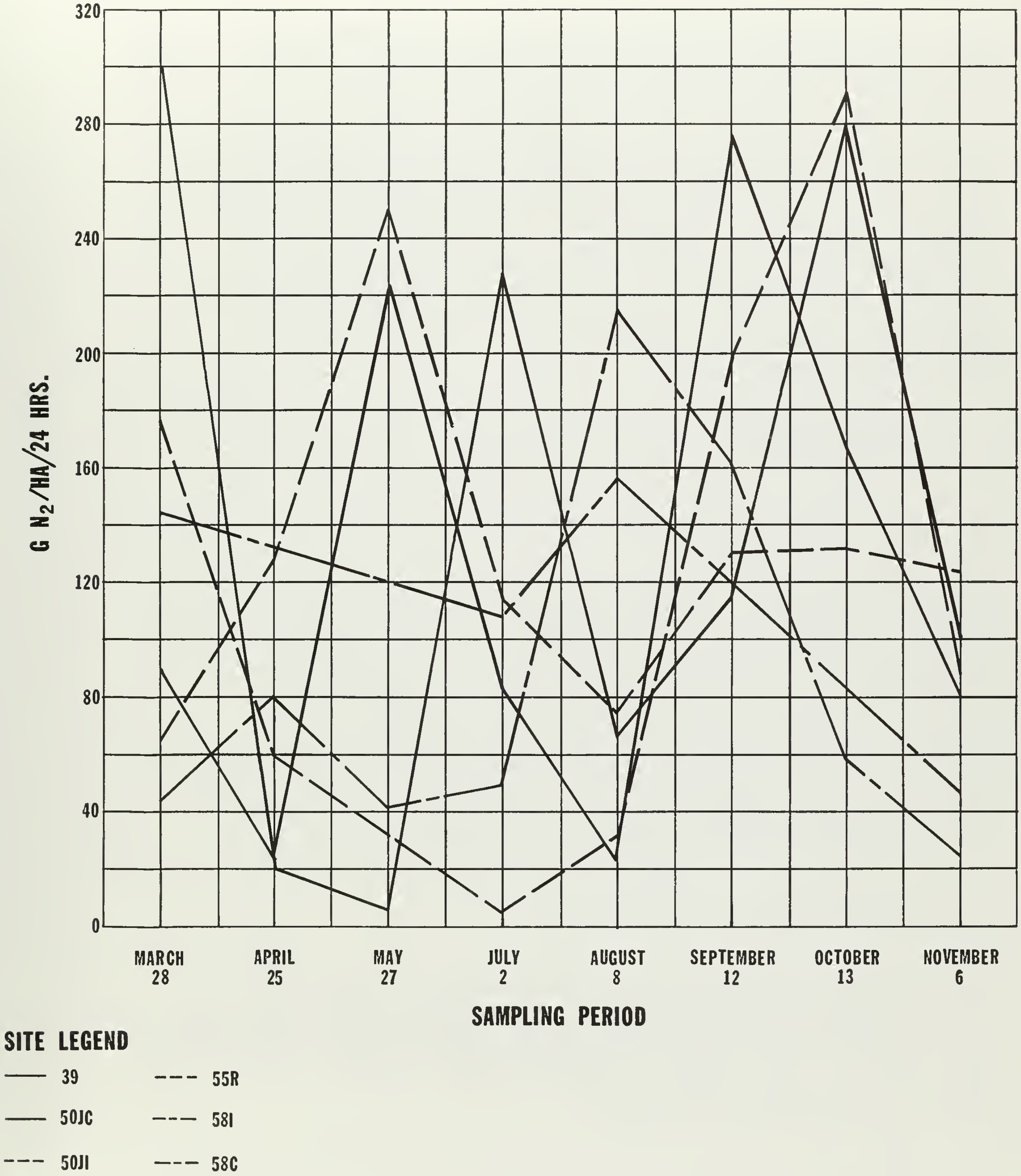
FIGURE IV-7

TABLE IV-29

NITROGEN (N_2) FIXATION

g N_2/ha/24 hr illumination

Sample	8 Aug. 1975	12 Sept. 1975	13 Oct. 1975	6 Nov. 1975
39-1	23.04	275.27	157.28	80.33
50JC-1	67.86	114.58	279.05	103.16
50JI-1	31.50	197.87	291.73	86.67
55R-1	70.18	129.38	131.91	123.46
58C-1	157.92	118.38	-	44.82
58I-1	215.63	160.45	59.40	25.79



vtn

NITROGEN FIXATION - 1975

FIGURE IV-8

Site 55R appears to reach a peak of N_2 fixation in mid-spring. The steady moisture and low nutrient influex, however, allows for a fairly consistent rate of fixation through the remainder of the year.

Ammonium nitrogen data correlate closely with nitrogen fixation rates, in that low levels of exchangeable NH_4^+-N occurring in the summer are evidence of decreases in mineralization of organic-nitrogen forms. Carbon/nitrogen values also indicate that this is the case, since they are highest from mid-spring through summer with a resultant increase in nitrogen immobilization. Since carbon to nitrogen ratios were low (9.0 - 10.0) at Site 55R and the exchangeable ammonium was high through spring, a peak in fixation in late May is expected.

C. WORK SCHEDULED

1. VEGETATION

The spring field analysis of vegetation is planned for June 7 through June 18. Obtaining a statistically adequate data sample is expected to take longer than usual. Professor Art Holmgren will conduct a training session on plant identification in which he will review for the team all of the local plant species in flower and in a vegetative state.

A sampling procedure developed for measuring the leader length of sagebrush will be applied during the spring field analysis. This measurement is intended to serve as a baseline value for comparison with subsequent measurements taken to assess environmental effects.

2. TERRESTRIAL VERTEBRATES

An attempt to identify bats (Chiroptera) using mist-nets will be conducted in the last week of May. The June sampling period for birds, amphibians and reptiles, and mammals will follow. The August sampling period, which will include use of the large rodent-trapping grids, will be followed by another week of bat netting.

All amphibian-reptile field work will be completed during one week of each month of next quarter, with the exception of October observations on walking transects. Other projects include:

(1) Continuation of deer monitoring program with expansion to include 24-hour monitoring.
(2) Completion of pellet group transects.
(3) Bi-weekly mourning dove coo-call counts.
(4) Waterfowl census-monthly.
(5) Raptor production survey.
(6) Trapping program to attempt to collar bobcat and/or coyote.
(7) Coyote denning survey.

3. TERRESTRIAL INVERTEBRATES

Monthly trips will be made during the forthcoming quarter to sample the species on the most abundant plants of the area for invertebrates. These will be processed for counting during the fall quarter. Additional determinations will be made at Logan, and additional groups will be sent out for determination. An effort will be made to organize the accumulated information into ecological patterns that will be useful in the formulation of a final environmental baseline report.

4. AQUATIC BIOLOGY

Periphyton samplers will be maintained in the streams as conditions permit. Sample strips will be changed at monthly intervals and analyzed by the USGS.

Fishery sampling will be attempted in late July or early August if it is approved by the DWR and the U.S. Fish and Wildlife Service. Final baseline sampling of all aquatic components will be undertaken in late August.

5. MICROBIOLOGY

Laboratory analysis will continue and samples will be collected during the summer quarter.

V. REVEGETATION STUDIES FOR DISTURBED AREAS AND PROCESSED SHALE DISPOSAL SITES

A. WORK COMPLETED

Maintenance of the plant propaged for use in field plantings continued at the greenhouses in Logan and Ephraim, Utah. The seeds of over 55 native shrubs, grasses, and forbs have been prepared and cleaned and are being stored for field and experimental plantings. Small samples are also available for exchange with other researchers in oil-shale revegetation.

In March the Institute for Land Rehabilitation visited the research site in Section 6 (north of the White River and U-b) to observe the species transplanted in October, the condition of surface stabilizing materials, and the developmental condition of plants in general.

About 600 spring plantings were made for studying plant establishment on disturbed areas. Grasses, forbs, and shrubs were direct seeded, bare-root planted, and container-grown in study plots at Station G-3, Station G-17 and Section 6. Four 2-by-2 frames and four 1-by-2 frames filled with processed shale to a depth of 5.5 cm in November 1975 were planted with container grown shrubs, forbs, and grasses to observe survival and growth when transplanted directly into processed shale.

Shrub species' field response to root pruning in the nursery was studied at the Section 6 field site. Six individuals of three shrub species from six sources were transplanted in April.

The effects of antidessicants on bare-root shrub transplants are being studied at the Section 6 study site. Individual groups of five shrub species were sprayed with "wiltproof," sprayed with 1:1 solution of "weathershield," dipped in a 1:10 solution of "wiltproof." A control group receiving no treatments is included in the experiment.

Six shrub species were field planted in a dense stand of cheatgrass to test the competitive ability of various container-grown plants.

The best techniques for rooting sagebrush cuttings are being determined by studying plant variability and the effects of season and rooting hormone treatments.

B. DATA SUMMARY

No data yet available.

C. WORK SCHEDULED

The establishment success of spring 1975 plantings will be evaluated in the field. New studies will be developed this summer using Union Oil Company and Paraho processed Utah shale to investigate techniques for vegetative processed shale.